THE RADIO SPECTRUM INTERNATIONAL ALLOCATION AND REGULATION

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THESIS

THE RADIO SPECTRUM INTERNATIONAL
ALLOCATION and REGULATION

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The Radio Spectrum
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ABSTRACT

This thesis contains a study of International Radio Spectrum Allocation and Regulation with particular emphasis upon the U.S.'s relationship with the International Telecommunications Union. (ITU). The authors develop a model of the technical, political and economic aspects of the radio spectrum allocation and regulation processes. The principal elements of the model concern the benefits of use, increased demand, cost of technical expansion, technological advances and the decision making process of the international regulatory body. In particular, a significant amount of attention is directed toward the historical development of the ITU and spectrum allocation within the framework of the authors' model. Concluding work focuses on the use of the model to determine possible U.S. courses of action with respect to future World Administrative Radio Conferences (WARC).

TABLE OF CONTENTS

I. INTRODUCTION

Since 1906 international radio frequency management has been carried out by the International Telecommunications Union (ITU). Over the years this organization has developed spectrum allocations and procedures through its Administrative Conferences. The results of each Administrative Conference have great impact upon the future technology, economics and politics of member nations. The next scheduled Conference is to be held in Geneva in October 1979. The authors have attempted to model the process by which the frequency spectrum is managed. The model is introduced in Chapter II along with a description of the characteristics of the spectrum it regulates. Chapter III presents the historical basis for the model and Chapter IV contains a description of the environment within which it must function. Utilizing the model, Chapter V presents some specific allocation alternatives and possible methods of modifying future outcomes. An Appendix is included to describe the organization of the ITU and the method of preparations for a World Administrative Radio Conference (WARC).

II. THE RADIO FREQUENCY ALLOCATION MODEL

The International management of the radio-frequency spectrum has become one of the most complex and frustrating problems facing the world community. Like water and fire, the benefits of the spectrum are heralded by all. But also, as water and fire, it's uncontrolled usage is counterproductive. It is the opinion of the authors that regulation of the spectrum in some form is a necessity. The more scarce this resource becomes the more important regulation becomes.

Regulation can take different forms. The traditional form of the International Regulatory Body is used here since it is the present method of spectrum allocation. In an attempt to model this process, we have started with the simple supply and demand relationship and have added the cause and effect interplay of technology, economics and politics. It is the continuous interplay of these factors that has shaped and reshaped the radio spectrum through the years.

The underlying premise for the model is that the radio spectrum exhibits many aspects of a "collective good". As such the spectrum is not beneficial to a single user. "Collective goods" are collectively consumed and limitations on use are difficult. Because of these characteristics, when the spectrum is available to two or more users it is available to all. The only requirement is to have the necessary equipment. Also in accordance with "collective good" theories, the additional users do not increase the marginal cost of spectrum

availability. A large number of users can however increase the marginal cost to individual users through interference. It is therefore essential to the effective use of the spectrum to have mutually agreed upon frequencies and at least an implied if not actual network concept available. In other words the benefits of effective spectrum usage accrue from agreed upon usages for specific frequencies and non interference of uses.

A. THE MODEL

To construct the Radio Frequency Allocation Model, we start with the finite amount of spectrum available for use. Some portions of the spectrum have numerous uses while other portions have very few. It is reasonable to assume that demand for the portions of spectrum with many possible uses would be high and demand for the less usable portion would be small. The large demand tends to cause saturation and inefficiencies at various spectrum locations. It also stimulates technological advances to alleviate the saturation. Continued expansion of the spectrum provides new uses and some substitutibility for older uses. As demand continues to grow, technological advances will expand supply, but at a slower rate and increased cost. As cost increases it becomes more economical to modify existing portions of spectrum so that it is available to more users. The logical progression leads to a spectrum that is saturated, with further expansion costs prohibitive to most users.

International Regulation attempts to control this spiral by a more equitable allocation scheme and a reduction of associated technological costs, through the combined political

effort of its members. This is accomplished by arriving at an agreed upon consensus for procedures and allocation through international conferences. It also introduces the additional factors of political action, international negotiation and bureaucratic sluggishness. As the system functions, historical precedents have a significant effect upon allocation. Most of the factors noted previously do not compliment each other. Each adds its own complexity to the model. With some factors diametrically opposed there can be no ideal solution. The optimal solution is one that provides the most benefits to the most people at the least cost.

The outputs of the model are the allocation decisions. Any output will provide some benefits to the constituent community and also associated costs. Increased benefits can tend to further increase demand by creating new inputs. Increased costs associated with allocation decisions tend to decrease the marginal cost of expanding or modifying the spectrum. This further modifies the input process, stimulating the technological and regulatory action. Figure [1] depicts the Functional Radio-frequency Spectrum Regulatory Model constructed by the authors.

Three characteristics of the model should be addressed further. First, is the model in equilibrium; second, does the model exhibit stability and third, can the model be equalized?

The first characteristic is equilibrium. It is the authors' opinion that if the model is in equilibrium there must be an equalization of the costs associated with the input paths. In other words, the cost of technological advances must be equal

RADIO-FREQUENCY ALLOCATION MODEL

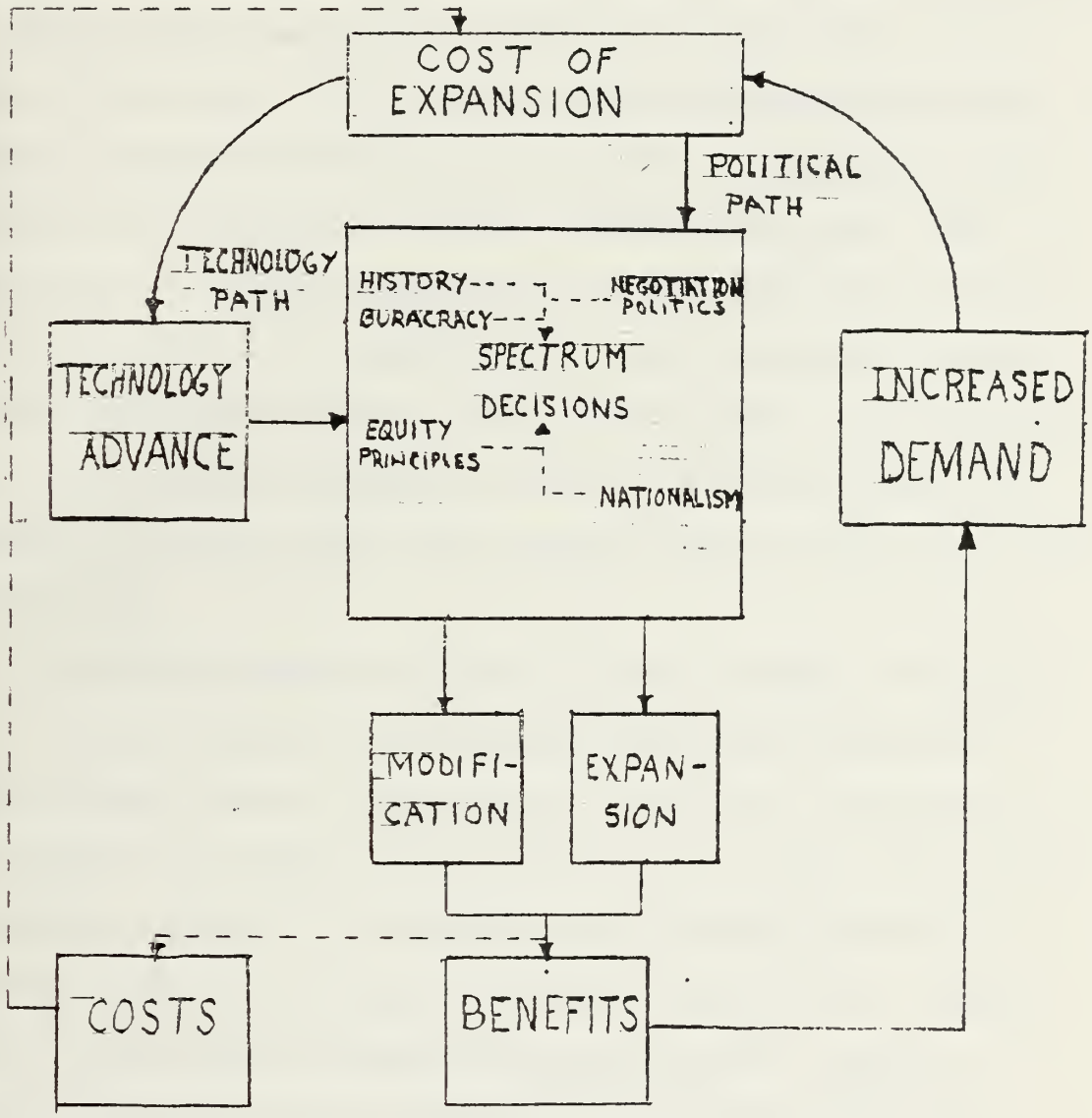


Figure 1

to the cost of political or regulatory action for all participants. If that condition exists, it should not matter which path is chosen. In effect the outputs would satisfy the increased demand and the model would be in equilibrium. This is not however, the present situation. The views stated in Chapter IV by the U.S.'s ambassadors demonstrate clearly that the U.S. does not look upon the two input paths as having equal costs. The U.S. position historically, as stated in Chapters II and IV, has been a preference for the technological path. The remainder of the participants have, on the other hand, shown a proclivity toward the political path since its cost to them is significantly less than the technological path. These inequalities are discussed further in Chapter IV. Based on our research, the authors are of the opinion that the model is not in equilibrium.

The second question is, does the model exhibit stability? That is, does the model tend toward equilibrium through its processes and does the functioning of the model over time tend to equalize the technological and political costs. The question is complex because it is dependent upon the internal and external factors that affect the model. The authors' view is that if the external factors are ignored and the internal factors are stable then, theoretically, the model will tend toward equilibrium. The internal factors include the structure of the ITU, economic conditions in each nation, political ideology of individual participants and negotiation strategies. If these were stable, over time a clear consensus would emerge which would tend to move the model toward an equilibrium point.

This equlibrium point would be a function of the final mix of the above factors. These factors are discussed further in Chapter IV.

The external factors noted above are those events that occur exclusive of the model that affect its function. Both World Wars were such events. As discussed in Chapter II, historically these external factors have pushed the model away from equilibrium by causing imbalances in the costs associated with both input paths. Both World Wars and the space program in the U.S. created communications related technological advances that made the technological path more attractive than the political. Using the above assumption the authors perceive the model as tending toward an equilibrium at any given time. It is also our opinion that in the real world since the internal factors are not stable the equilibrium point itself changes. In effect the process "hunts" for this equilibrium point over time until an external factor pushes it significantly out of balance again so that equilibrium is always out of reach.

The third question is can the model be equalized? In other words can the model be forced closer to equilibrium? In the view of the authors there are methods that will move the model toward equilibrium. Alternatives to accomplish this in the specific areas of HF and satellite bands are presented in Chapter V.

B. THE FREQUENCY SPECTRUM AS A NATURAL RESOURCE

Of the entire range of frequencies that constitute the electro magnetic spectrum, only that portion from about 10 kilo-hertz (kHz) to 3 billion kilo-hertz is classified as the

radio spectrum. This spectrum is a natural resource, just as are coal, water or air. It is similar to air and water in that it is susceptible to oversubscription and pollution. The world has become highly dependent upon the electro-magnetic spectrum in recent years, primarily in the field of telecommunications and automated data processing but also for such electronic conveniences as micro-wave ovens, automatic garage door openers and radio controlled models. Presently, except for some experimentation, only that portion of the spectrum from 10 kHz to 275 GHz (275×10^9 Hz) can be utilized. This comprises only 9.2 percent of the radio spectrum![26, p.18] This simple statistic makes it obvious that use of the radio spectrum is not simply a matter of building a piece of equipment to operate at an unused frequency.

In technological terms the natural resource of the radio spectrum as we know it has finite limitations. It is not elastic. Frequencies used to represent channels of communication are not just numbers which may be divided into smaller numbers without limit. Each radio operation requires a finite portion of the spectrum - a channel or traffic lane - in time and space. The spectrum is not flexible. Certain operations can be performed only by using specific frequency ranges. All parts of the spectrum cannot be substituted for all other parts because of propagation, atmospheric and bandwidth characteristics. For example high frequencies (3 to 30 MHz) are useful for low capacity long range circuits but are inadequate for high capacity circuits such as television.[54, p.A-6]

The radio spectrum also has usage limitations. It does not follow national boundaries. The interference range of radio signals is much greater than their useful range, and uses must be coordinated and the spectrum shared among nations. As a natural resource the radio spectrum is unique. It cannot be exhausted through use or worn out; but careless or inefficient use can contaminate it and can prevent its maximum benefits from being obtained.

As with any valuable resource, the radio spectrum has been developed in relation to its supply and demand. The demand for radio spectrum increases yearly because it offers an instaneous and direct way of communicating across space. Modern decision makers in government and business are dependent upon the transmission of voice, data and the printed word. It has become absolutely essential to the safety of air and sea travel, and to the command and control structure of the United States and other developed countries.[54, p.A-1] It also reflects growth in levels of population and per capita income and individual/group preferences. This burgeoning demand also has associated problems or costs that must be borne by the transmitter and recipient, private or public, the governments of the world, policy makers, equipment manufacturers and those who are concerned with the content of the information rather than the technology by which it is transmitted.[26, p.xiv] On the supply side technical advances have improved the use of spectrum along its dimensions of time, space, and frequency. At the same time other technological advances are making it possible to use spectrum at higher and higher frequencies.[54, p.A-5]

III. HISTORY

The Radio Frequency Allocation Model is derived from the historical interplay of technological and international political factors. This Chapter discusses the historical patterns that have contributed to the model. The history is divided into three sections, each representing a different stage of development. The first stage from 1906 to 1957 was the period in which the technological path of the model developed and became dominant. The period 1957 to 1971 was a transition stage during which the political path developed and began to compete with the technological path. The final stage from 1971 to the present has been a period in which the political path has begun to emerge as the dominant path of the model. The last section summarizes the historical development of the model.

A. 1906 TO 1957

The first International Conference on Radio was held at Berlin in 1906. It was attended by twenty-seven nations. The purpose of the conference was to "facilitate maritime intercommunication by obligatory intercommunication between stations using different equipment".[16,p.26] The U.S. governments position as stated in the delegations instructions was that the conference was for technical and practical recommendations that could be reviewed and acted upon by government agencies at some later date.[16,p.26] This approach was markedly different from that of the other conferees. These conferees were empowered to act as plenipotentiaries directly answering for

their governments. Reference 16 notes that Americans were looked upon as novices in the international arena during this period while Great Britain was looked upon as the leader. This was only natural since most of the telecommunications interests available internationally were owned by the British Marconi Company. The conference was dominated by the opposing views of the British and American delegations. The British, arguing from economic and political interests, wanted restrictions on the interchange of telegrams and radio-messages at sea. This would have allowed the British Marconi Company to maintain its near monopoly in this field and also would have maintained Great Britain as the prime influence in the future of telecommunications. The British backed restrictions would have stifled innovation by placing almost insurmountable barriers to entry on the industry.[16,p.27] Their position was, "that different systems of radio-telegraphy are not always able to communicate effectively one with the other."[16,p.28] The American delegation, having prepared for a technical conference was in a good position to oppose the British. First, this period in the U.S. was marked by much government discussion of the new telecommunications industry.[16,p.28] There was a great amount of concern that this new industry might fall prey to monopolistic interests as had happened to the telephone; American Telephone and Telegraph was presenting arguments similar to the British in an attempt to preserve their interests. As in the domestic telephone industry, it could be demonstrated that different systems could be used effectively without affecting the quality of transmission; in fact, the quality in some cases was

enhanced.[16,p.27] Secondly the U.S. was determined to forge a cooperative stance with the other nations of the world. The interchanging of messages between systems was seen as a method of furthering internationalism. After long and bitter debate the American view was accepted, allowing for interchange of messages. The frequencies 500 kHz and 1,000 kHz were allocated as the first general public service frequencies. (SHIP/SHORE). [54,p.B-2] It is the authors' opinion that for the U.S. the decision was politically, economically and technically sound. It also catapulted the U.S. into a leadership role in the telecommunications field. Also of note at the first conference were two little debated decisions that were accepted unanimously- the designation of Morse SOS as the international distress signal and the formation of a central depository for technical telecommunications data available worldwide.

The second International Radio Conference was held at London in 1912.[16,p.32] The U.S. delegation was the dominant factor at the conference. It was assumed, even prior to the meetings, that the technical suggestions made in London would be accepted by the conferees. In fact pending domestic radio legislation, the Ship Act amendment and the Radio Act amendment, already contained the U.S. proposals as part of their provisions.[16,p.33]

It was commonly believed at that time that only the lower portion of the radio spectrum was usable for communications. United States proposals for sharing the spectrum (150 kHz to 1,000 kHz) were quickly accepted. While not formalized in writing the allocations were:[54,p.B-3]

A. below 200 kHz - long distance point to point

B. 375-550 kHz - ship - shore working frequencies

C. 550-600 kHz - broadcasting

D. 600-1,000 kHz - shared among broadcasting, ship/shore and experimental purposes.

The 1912 conference provided little controversy among the forty-three nations present.[16,p.33] The United States was recognized as the economic and political leader on the international scene, thus, the next conference was set for 1917 in Washington D.C.

This leadership in communications matters was aided by the technological advances made by the entrepreneurs of the U.S. The single most important invention was Fessenden's heterodyne transceiver. By mixing two frequencies, one at local oscillation and the other much higher, a third frequency was created for transmission. In the receiver the mixing action again restored the local frequency. This breakthrough coupled with DeForest's triode demonstrated that higher frequencies could be modulated with voice signals and transmitted. Thus the spectrum limits were extensively expanded.[2,p.89]

The authors' opinion is that World War I was devastating in its impact upon the world community. Political and economic chaos were the order of the day in Europe. Technology, however, flourished as nations attempted to gain strategic or tactical advantage. The U.S. Navy was one of the pioneers conducting extensive radio frequency experiments and utilizing radio transmissions for tactical purposes.[43,p.19] The Germans and British did the same. Since all ship/shore equipments

were grouped in a narrow band, interference was common and added more emphasis to the need for spectrum expansion.

The conclusion of the War was marked by a new spirit of internationalism and cooperation.[16,p.34] Preliminary allocation conferences were held among the Allies starting in 1919 and a full conference was scheduled for 1927 in Washington D. C. At the very first post war meeting a proposal was submitted recommending that allocation of frequencies to radio services be discarded as a principle and that frequencies be allocated to countries. It is of interest that while the proposal was dismissed it was to be considered again in the future.[43,p.20]

By the time the seventy-nine nations convened the Washington Conference, radio stations and uses were proliferating throughout the usable spectrum. Broadcasting was operating at up to 1,500 kHz. In the period of 1922-24 alone, the number of broadcasting stations increased from 30 to 500.[33,p.540] This new utilization of spectrum space also led to substantial profits that would bring economic pressures upon future spectrum allocations. Additionally, radio amateurs were firmly entrenched at several points in the spectrum as was the Navy, Army and some private corporations, notably Bell and RCA.[50,p.104]

The above interests succeeded in pressuring the government to protect existing services at the Conference. New allocations were interlaced into slots on the allocation table. The technical expertise belonged to the private corporations. Arguing from both an economic viewpoint (major changes in existing services would cost large sums of capital in equipment modifications) and from a technical view (the services are

operating at efficient points on the spectrum) the private sector influenced directly the U.S. proposals and therefore the international allocations.[16,p.47] In an attempt to provide a more orderly utilization of the spectrum in the future, the conference allocated frequencies up to 23 MHz even though actual usage was only up to 18 MHz.[43,p.21] Even more significant, an international technical agency known as the Consultative Committee on International Radio (CCIR) was established to cope with future technical problems.[50,p.105]

The period following the 1927 conference witnessed a rapid growth of all existing services, both in extent and in technical perfection. The development of new services, and the opening of new frequency bands in the region above 30 MHz followed. Navigational aids, aeronautical communications, land mobile, and television broadcasting services came into being or were under development. By 1930 round-the-world broadcasting was effected.[33,p.540]

The next major International Conference was to be held at Madrid in 1932. Although investment capital was scarce in the U.S. due to the depression, the communications market outlook was more optimistic. In 1931 NBC reported net profits of $2,325,229 and CBS $2,346,766. NBC offered 61 stations coast to coast while CBS offered 79.[3,p.250] During that same year Britain went off the gold standard, 325 American banks closed in September of 1931 and 522 closed in October. The following year, 1932, as the depression deepened and unemployment rose, NBC still reported a net profit of $1,050,113 and CBS, $1,623,251.[3,p.252] The population could not afford dinner

out or movies and so they turned to the radio. The broadcast industry flourished. The new economic power of the industry converted readily to political power in communications matters. The broadcasters main concern was the same as the other participating nations; namely the uses of the spectrum were expanding so rapidly that additional wavelengths were needed.

The first order of business at Madrid was to merge the previously enacted International Telegraph Convention and International Radiotelegraph Convention, into a new organization, the International Telecommunications Union (ITU) with headquarters in Berne, Switzerland. Thus an international organization was born to allocate the radio spectrum and to forge cooperation among the nations of the world. The organization of the ITU is discussed in detail in appendix A.

The next order of business was the expansion of the broadcasting allocation. Internally, U.S. interests were divided. The radio and electronic component companies had realized through experience and economies of scale that spectrum expansion into adjacent areas would require the least modifications and provide the most economic benefits.[16,p.76] The Radio manufacturers association ignoring cost, argued that use of lower frequencies would improve reception. This was countered by the Bell Labs contention that longer waves (lower frequencies) would mean new receivers would be necessary at higher cost with a relatively small increase in quality.[16,p.76] It was an understandable argument since Bell wanted these frequencies for its newly instituted transatlantic telephone operations.[50,p.69] At the higher end the Maritime interests,

citing their own needs for frequencies, were adamantly against giving up part of their present band to broadcasting. The government, recognizing the conflicting views of these powerful domestic interests, opted for very minor changes to the existing spectrum allocations, preferring that modifications could be made internally and outside of the international arena. This was a logical domestic political course since new communication legislation was pending in Congress. (Communications Act of 1934)[16,p.81]

The Madrid conference made minor changes to the 1927 allocations and allotted additional frequencies up to 30 MHz due primarily to the lack of U.S. support for more comprehensive changes.

The period between 1932 and the 1938 Cairo conference was marked by continued advances in technology. In 1933 Alexanderson developed frequency modulation in an attempt to reduce noise and interference in the high frequency bands. While this was a significant improvement, the commercial broadcast interests failed to capitalize on it because of the necessary high cost design changes to transmitters and receivers. [33,p.541] It was not until late in the decade, after Alexanderson's concepts had been tested commercially that this concept was fully embraced by broadcasting. Additional advances in coaxial cable made it possible for AT&T to transmit many phone conversations on a single line without interference.[33,p543] This eased the pressure on the spectrum in general and broadcasting in particular. Television and Radar research was also moving from the drawing board to experimentation during this time.[33,p.544]

The Cairo Conference, known also as the second ITU Conference, was held in 1938 with eighty countries attending.[16,p.82] The purpose of the conference was to further tighten the existing rules for allocation of frequencies.[16,p.83] There was an increasing demand for additional radio frequencies due to a rapid expansion of the mobile, fixed, and broadcasting services. The growing saturation of spectrum made it increasingly important to make the most economical use possible of the facilities and to reconsider the Madrid Allocations.

The Cairo conference approved extensions of the frequency spectrum, blocking in allocations up to 300 MHz for future use.[54,p.B-4] The U.S. delegation approached this conference with the idea that sound proposals would lay the ground work for future allocations. These allocations could then be meshed into the Allocation Table with minimum debate. In the authors' view this made good technical and economic sense since the U.S. was dealing from a position of strength. Technologically the U.S. was significantly ahead of the other members of the ITU in the development of more powerful and efficient electronic equipment. As the U.S. began to emerge from the depression period, large amounts of investment capital became available to the communications industry.[16,p.84] An example of this U.S. approach was its recognition of the future importance of aircraft. Even though the aircraft industry was still in its infancy the U.S. sucessfully sponsored allocations for the aeronautical service in a number of bands to allow for future growth.[16,p.86]

Prior to the Cairo conference the U.S. had called a series of regional conferences and alleviated allocation problems, so that when the main conference convened the Western Hemisphere presented a united front while the Europeans continued to be split over the future uses of the spectrum. The logical result was that the U.S. dominated the Cairo conference.[16,p.87]

World War II, starting in 1939, brought forth new uses of the spectrum such as radar, great expansion in aviation with its need for instantaneous and reliable global communication, vast use of mobile two-way radio, FM/TV broadcasting and microwave radio relay. The U.S. military alone had a functional allocation plan up to 30,000 MHz.[54,p.B-4] New uses of VHF and UHF became established immediately upon the advent of technical means to generate, radiate, and receive higher and higher frequencies. Thus many services became established at a time when it was not known whether the particular frequency band adopted was best suited for the service, and large investments in facilities which followed would make it difficult to consider reassignments on a more efficient basis. Furthermore, the importance of a new service could not be accurately predicted, and therefore its share of spectrum space had to be estimated in inexact terms.

Several shifts in allocations within the U.S. were made between 1938 and 1945. For example, when the time came to allocate bands for television service, in replacement for those which had originally been set out prior to the war, it was found to be impossible to provide for all the requirements in

one continuous band located where the best radio-propagation conditions for television exist. This was because of the already widely established uses by other important services, such as aids to air navigation.[43,p.23]

With the conclusion of the War in 1945 it became apparent that international coordination would be necessary to cope with the many expanding services and the international disorder in the recording of radio-frequency assignments. To resolve these matters an International Conference was convened at Atlantic City, New Jersey in 1947. This conference was dominated by the victorious allies.[16,p.91] They did not agree on all proposals, but for the most part worked well together.[16,p.92] The reorganization of the ITU was an important item on the agenda. This work was expedited by the U.S. Department of State circulating its preliminary proposals to other members prior to the conference.

The Soviet proposals for ITU reorganization were practically a copy of the American proposals. All five allies felt the remodeled ITU should have an Administrative Council and a permanent Secretariat. A Central Frequency Regulation Board (CFRB) was a distinctive U.S. proposal. Up to that time the Berne Bureau was publishing a frequency list which was compiled simply by countries notifying the Bureau of the use of a specific frequency. The Bureau had no powers, but served merely as a registry office.[16,p.93] Conflicts of prior clearance of frequencies would be resolved by the new board.

Resolution of the spectrum allocation problems was achieved through compromise, but the final results contained the basic

United States' proposals. Some controversial issues were bypassed and left for future special conferences. For example, the U.S. and the rest of the Western Hemisphere wanted a maximum allocation for amateurs, but the European powers wanted only a minimum number of amateur bands. The final result was a loss of some existing allocations in the old band but a gain in a new and wider band in another part of the spectrum.[16,p.93]

The principle of regionalization was accepted at the conference, dividing the world into three regions.

In an effort to implement the Atlantic City frequency-allocation plan, many international meetings were held. The Provisional Frequency Board was in session for over two years, commencing in 1948. The Board failed to produce an acceptable frequency assignment list, because it could not resolve the conflicting requirements of members. The countries of the world generally submitted requirements, including needs for the future, in excess of the capacity of the pertinent parts of the frequency spectrum to accommodate them.[43,p.24]

Two conferences were held in 1949 and 1950 to prepare a plan for frequency assignments for HF broadcasting stations. These conferences also failed to agree on acceptable arrangements. An International Administrative Aeronautical Radio Conference met in 1948 and 1949 and adopted a plan for aviation which, however, could not be made effective unless there was an acceptable international solution of the assignment problem for stations of other services in bands which aviation was to occupy.[43,p.24]

Meanwhile, disturbed world conditions initiated by the war in Korea, followed by the mobilization activities of many important countries, intervened, and imposed restrictions on effective international collaboration in telecommunications. Furthermore, because of the unprecedented growth of some services, particularly international broadcasting with its psychological warfare aspects, many countries of the world found it expedient to ignore the international agreements already in effect and assign stations to frequencies outside the internationally allocated bands. The Extraordinary Administrative Radio Conference which began its meeting in August 1951, was not able to carry out its originally contemplated mission of approving a new complete master list of frequency assignments because of the failure of the Provisional Frequency Board to produce acceptable frequency lists for the fixed and broadcasting services. Instead the conference found its activities limited chiefly to such agreements as could be reached for promoting evolutionary procedures for putting the fixed and broadcasting stations in the frequency bands allocated to those services at Atlantic City. It did however, approve planned frequency assignments for the aeronautical and maritime services.[43,p.24]

In the United States much progress was made, meanwhile, in the allocation of frequency bands and the assignment of frequencies to stations in the spectrum above 30 MHz, particularly in the fields of television and land mobile services. It proved impossible to give the new services the frequencies best suited for them even for those cases where the

characteristics of the applicable frequencies and equipment technology were relatively well understood.[43,p.25]

B. 1957 TO 1971

In the interests of a more orderly allocation of the spectrum, a bureacracy had been created in 1947. The new organization made it easier for smaller, lesser developed countries to have a say in spectrum allocation, a democratic idea. At the same time it is the view of the authors' that the additional number of voices would tend to dilute the developed countries' (most notably the U.S.) power at future conferences.

The secondary impact may have been even more significant to the future of telecommunications. The countries of the world were provided with assistance and technical knowledge by the ITU through its consultative committees. Thus options previously not available to lesser developed countries became usable. The period following World War II marked the beginning of the end for colonialism [30,p.31] Each year more independent countries emerged. Colonialism gave way to spheres of influence as the East and West vied for leverage in the Third World. Most of the newly emerging nations had very little in the way of economic or political bases. Their nationalistic zeal to catch up and thrust themselves into the twentieth century caused them to align themselves economically and sometimes politically in one or the other of the major spheres. International markets are a necessity for lesser developed countries, both to buy needed commodities and to sell their own products. To compete efficiently in these markets, adequate telecommunications are essential. Telecommunications can also be used

to inform, and to some extent control, the populace. These uses illustrate that telecommunications is a powerful tool for governments of lesser developed countries. It is the view of the authors that the period of the fifties saw more and more nations use this tool.

With the above underlying it, the decade of the fifties was a period of economic and technological growth. Space, television and microwave systems became operational. At the same time the major countries had significant success in shifting frequencies for various services to more efficient blocks of spectrum in accordance with the 1947 allocation table.[43,p.25] Several small regional and specialized conferences were held to more efficiently allocate and use the spectrum. These included the Maritime VHF Conference in 1957 and the European Broadcasting Area Conference of 1961.[43,p.25]

A Plenipotentiary Conference of the ITU was held at Geneva in 1959. Concurrently an Administrative Radio Conference adopted Regulations under which the useable spectrum was considered as extending to 40,000 MHz.[43,p.26]

At the 1959 conference the Lesser Developed Countries obtained an increase in the number of members assigned to the ITU's Administrative Council from 18 to 25. [7,p.15] The increase was a concession to the LDC's call for more representation in the allocation process. The vacancies were filled with four delegates from the African Region and one each from Asia, Australia and Europe. Also added to Article 4 of the ITU's "Purposes of the Union" was a statement that in the future, "...it (ITU) would foster the creation, development

and improvement of telecommunications equipment and networks in new or developing countries by every means at its disposal, especially its participation in the appropriate programmes of the United Nations."[6,p.13] These Third World stirrings prompted the American delegate to comment that, "..the tremendous interest of the new and developing countries in technical assistance... was the most significant single trend noted at the conference."[6,p.14]

As an outgrowth of the IFRB's work during the fifties the 1959 Conference strengthened the Board's procedures for recording frequency assignments of which it received notice.[43,p27] Its review would now include an investigation of existing allocations and possible interference with other users. The Geneva Conference of 1959 marked the first time that recognition was given to the fact that portions of the spectrum were becoming saturated, most notably the 4 to 27 MHz HF band. A special panel was established to study the problem, and its final report listed 38 recommendations to reduce congestion.[43,p.26] Most of the recommendations of the ITU HF panel have been implemented; unused or seldom used point to point and broadcast circuits have been terminated, many operations have been converted to single sideband (SSB), more high-capacity submarine cables have been brought into use on a number of routes, greater use is being made of directive antennas, and communications satellites were studied for use.[43,p.27] Most of these recommendations were implemented by the developed nations of the world to accommodate the lesser developed countries' HF needs. At the conclusion of the 1959 Conference

the U.S. delegate filed these reassuring words in his final report.

> The Conference provided the opportunity to advance with representatives of other countries the position and point of view of the United States on International Telecommunications questions generally and to encourage full understanding and friendly cooperation between the participating countries. It is believed that the collaboration between the United States and other countries maintained the best traditions of the ITU in its long record of International cooperation and accomplishment.[7,p.16]

To the authors' knowledge this was the last such optimistic report filed by a U.S. delegate to an ITU Plenipotentiary Conference.

In 1957 the space age and satellite era began with the launch of SPUTNIK.[57,p.86] It began in a spirit of cooperation. The first satellite system designs were low altitude, random orbit satellites.[34,p.48] This type of system required thirty to forty satellites for full global coverage, each of which would be used at different times by different sets of earth stations around the world. Each earth station would require multiple, fully tracking antennas in order to establish communications links through successive satellites as they came into view, while maintaining links through satellites passing from view. To establish multiplicity of links among many nations would require complex scheduling of satellites, onboard radio repeaters, and earth stations. The complexity and cost envisaged for such a system, plus the fact that any one satellite would be of use to a particular nation for only a small percentage of time, led to the conclusion that the financing

and use of a communications satellite system would require global participation.[34,p.49] Accordingly in 1963, the International Telecommunications Satellite Consortium, later called INTELSAT was formed to develop a single global system of international satellite communications.

One of the political and economic realities of that period was the heavy investment made by European countries in cable systems.[34,p.46] Because they viewed the satellite systems as a threat to this investment, the Europeans procrastinated, possibly hoping a new generation of cables would make the question moot. Interestingly, it was satellite technology that overtook the new consortium. Before the final agreements were signed, the geostationary orbiting satellites became operational, with significant advantages. One satellite could cover forty percent of the globe, reducing a worldwide system to three satellites.[43,p.27] Other operational advantages of the geostationary configuration are of note. It soon became apparent that the fixed location and orientation of such satellites in relation to the earth's surface would permit the use of directive antennas, capable of producing more powerful illumination of the earth from the limited power capability. This antenna directivity would not have been useful with continuously orbiting unoriented satellites. Also the geostationary configuration rendered frequency sharing between earth stations and terrestrial radio relay stations much more feasible, since only one or at most few specific antenna pointing angles need be cleared from potential interference.[57,p.169] The

geostationary orbit became the optimum available means of providing communications satellite services.

In the final analysis, the use made of any communication mode will depend on the superiority of some alternative mode of providing a desired service. During the early to mid-sixties, the communications satellite proved more economical than its competition, undersea cable, microwave links, and HF.[19,p.27] There still remained the problem of frequency allocation. The radio frequency range in which the satellite services could best be developed (between 1,000 and 10K MHz) was already allocated among, the heavily used by, various terrestrial radio services. This conflict led to the specialized Space Extraordinary Administrative Radio Conference (EARC) in 1963. With the technical feasibility of sharing between satellite and terrestrial systems in the foreground, and the economic advantages of satellites in the background, a sharing scheme was approved. Specifically, it was determined that microwave radio relay services, with their narrow beam parallel to the earth's surface and satellite services, with transmission paths outward from the earth, could avoid harmful interference through coordination of the siting and design parameters of their systems. This case was the first in which two different classes of service were authorized simultaneous use of common operating frequencies in a common area, a significant precedent. Actually the sharing proposal was sponsored at the Conference by the U.S. and European interests, who had so much to gain, with little regard for positions of the lesser developed countries. The decision

was a major victory for the commercialized countries who, having had their way for so long, still believed they knew what was best for the world.

Politics and economics, factors that had heretofore remained in the background of telecommunications spectrum allocation were beginning to emerge and share the spotlight with technology. It was still necessary to show a proposal was sound technically, but it would become increasingly obvious that it must also be politically acceptable and economically advantageous to the majority. It was technically feasible to limit satellite signals to specific areas of the globe, thus reducing the need for uniformity among regions. Economically and politically however, it would remain advantageous to maintain uniformity. No longer was it sufficient to state that something was possible, now intent and justification would be debated before the world community. The view that the ITU was becoming a political forum at the expense of technology was typified by Professor Harold Jacobson of Michigan University when he wrote:[23,p.66]

> The ITU's present structure with its elaborate division of authority, is almost an invitation to bickering about picayune matters and may well discourage able personnel from association with the Union. It also tends to compartmentize the consideration of problems. This may have been appropriate when telephone, telegraph and radio were really quite different, but modern technological developments have made telecommunications systems more and more similar and interdependent. Wholistic treatment is clearly required.

Realistically the developed nations continued to pursue their interests on a narrow scale. The meetings to establish INTELSAT were limited to the U.S. and European countries.[34,p.56] The omission of the developing nations and the Soviet Union was intentional and justified on the basis that the nations which were present represented 90 percent of the international telecommunications traffic and because a premium was placed on an early completion of the negotiations.[34,p.54] The developing nations, while clearly technologically inferior, did not view themselves as political inferiors and saw their exclusion as a case of the "haves" holding back the "have nots." Their concerns were summarized by the Russian international legal expert, Mr. I. Chepov. His statement to the UN called for non-discriminatory access to the international system and stated that, "a truly global system could only be created through the ITU and the UN."[34,p.58] It was again being made clear that the lesser developed countries must be considered in future proposals. With the one nation one vote procedures of the ITU, the increasing number of emerging nations could be a powerful voice in that forum.

The Montreux Conference held in 1965 continued the movement of the union away from the lead of the so called colonial powers. At that conference major changes were voted, amending the structure of the union's hierarchy. The Administrative Council was enlarged from 25 to 29 members, primarily to placate the developing nations who continued to feel they did not have a voice in policy matters.[7,p.17] The enlargement opened seats for four of the Third World nations. The IFRB was reduced from

11 members to 5 members in effect weakening its standing. The United States had proposed that the IFRB be abolished completely and its functions transferred to the Secretariat. The Third World nations vehemently opposed this move, insisting that the IFRB was performing a vital function in aiding the developing countries select proper frequencies for particular uses. The U.S. viewed it simply as a matter of an unneeded service (for U.S.) and unnecessary expense. The above reduction was the final compromise.

In a purely political move, the Third World, after long and bitter debate forced the exclusion of white-ruled South Africa and colonial Portugal from the conference. The U.S. had opposed this proposal on the grounds that it was in direct violation of the Convention which all governments represented had ratified.[7,p.13] The Third World also made demands for fiscal and technical assistance. The mood of the United States' delegate reflected the changes since 1959 in his final report.

> ...it may be stated that if there was one dominant note at the conference it was the oft-stated belief that the ITU had as one of its basic functions the requirement to assist the new and developing nations with their individual telecommunications problems. [7,p.14]

One of the stated ITU functions is to expand and improve global telecommunications. It would seem the Third World's point is valid.

The Montreux Conference was not, however, a clean sweep for the Third World. They failed in three of their major goals:[6,p.13]

1. The establishment of a special ITU technical assistance fund over and above that provided by the United Nations Development Program (UNDP),
2. The establishment of Regional ITU offices in the LDC's to aid these countries in developing domestic telecommunications systems, and
3. The creation of a new and separate organization in the ITU to deal exclusively with development assistance matters which would be independent of the Secretary-General and which would have its own elected director as in the case of the CCITT (International Telegraph and Telephone Consultative Committee) and the CCIR (International Radio Consultative Committee).

It is the authors' opinion that this failure was a direct result of the unified actions of the developed nations, the fears of additional financial burdens and the continued political disorganization of the Third World.

The final results of the conference were mixed at best. Ever the optimist, the U.S. delegation's report read, "..There is reason to believe that the next Plenipotentiary Conference, of which it may be expected more experienced delegations from the developing countries will attend, will move in the direction of accomplishment of the United States objectives."[7,p.14]

It can be said that the U.S., during the decade of the sixties was sympathetic to the plight of the lesser developed countries. The U.S. supported many of the proposals that widened the role of the Third World in telecommunications matters. The sixties, though, were also a confused time. On

the one hand the U.S. was pouring massive foreign aid into the lesser developed nations and providing technological and economic assistance through programs sponsored by the U.N. and through the Peace Corps. It was also fighting an unpopular war in Vietnam. The arms race, Vietnam, and even the race to the moon affected our standing with the rest of the world. It is the authors' view that when the seventies began our technological standing was unsurpassed, our economic climate was good and our political standing was somewhat diminished in the view of the smaller nations of the world.

The Twenty-ninth General Assembly of the U.N. was indicative of the attitudes of the lesser developed nations. Often the U.S. could at most align blocs of two or three votes. The Soviet Union's diplomatic fortunes were on the upswing.[64,p.45] Though by 1971 it was apparent that the majority of the Third World states would not go Communist, it was nevertheless possible for the Soviets to discourage any good relations the Third World might have considered establishing with the West. The U.S. and Europe were seen as colonial powers while the Soviets were viewed as supporters of Third World Nationalism.

C. 1971 TO PRESENT

In 1971 an Extraordinary Administrative Conference on Space Communications was convened in Geneva. Its scope was limited to the problem of satellite frequency allocations. The conference allotted spectrum in the higher bands for use in satellite broadcasting and other satellite service. The overall increase was by a factor of 35.[54,p.E-8] The accepted proposals provided

technically sound allocations and the conference was notably free of political maneuvering.[54,p.E-8] Satellite communications was becoming the norm for many developed countries. This could free portions of the spectrum for use by other non-satellite users. Most notably it was believed these openings would come in the HF bands, heavily utilized by smaller nations. It is the view of the authors' that the nations of the world would support their own economic interests, and when proposals coincided with the interests of a large number of participants the outcome of negotiations would usually be successful. After this brief lull, the political factors moved once again to the forefront in 1973. At the Plenipotentiary Conference held that year in Spain, South Africa and Portugal were prohibited from participating in all future WARC's, this was due to their unpopular governments. At the same time the conference cancelled the membership of the U.S., Britain, French, Spanish and Portuguese territories thus additionally weakening the developed countries position. While the exclusion of U.S. Territories took votes from the U.S. it also reduced its financial contribution from 11 percent to 6.5 percent of the budget.[7,p.15] This loss of financial base prompted a resolution to change the system from voluntary to a United Nations contributory scale. Passage of the proposal would have raised the contribution share of the U.S. to 25 percent of the ITU budget. The measure was defeated only after a concerted effort on the part of the U.S. and the USSR.[7,p.15]

An additional resolution raised the number of members on the Administrative Council to 36. The majority of these seats

were given to the developing nations, thereby increasing their power. Another proposal established a voluntary technical cooperation fund over U.S. objections.[64,p.46] Proposals for establishment of regional ITU offices and the creation of a new Consultative Committee to deal with development matters were, however, again defeated.

In Spain the LDC bloc was led by Saudi Arabia, but it was Algeria who rallied the Third World at the 1974 Conference in Geneva under the battle cry of "equal rights for all."[64,p.48] The 1974 Conference was a specialized one dealing with maritime matters. The Third World countries marshalled their forces to impose on the Conference an Allotment Table and procedures based upon nationalism rather than sound engineering principles. A caucus of Middle Eastern, African, and South American countries with little or no technical support won approval of the new allocation table. Previously, the allotments were made to countries with a stated need with channel selections based on engineering, geographical, and operational criteria. Priority restraints were imposed with consideration for greater traffic loads and the seniority of the channel requirement. Thus, a limited number of allotments appeared on each channel with a recognized order of priority to be followed in case of harmful interference. Because not every country needed a coastal radio system, meaningless allotments to countries with no requirement were avoided. The new rules however provide maritime frequencies to all nations on an equal basis even if they have no coast line at all.[6,p.15] The procedural changes reversed the provision protecting first assignees to a frequency from interference

from a late arrival. It now provides for negotiation between the newcomer and first assignee. However, it also allows the newcomer in, under certain circumstances with full protection from interference equal to that of the first assignee, almost a technical impossibility.[49,p.3] The U.S. took a reservation to these proposals in protest of the politicization, as did several other nations. In the years since the creation of the ITU, the U.S. had never before taken a reservation on an allocation issue. A reservation means that the U.S. reserves the right to assign frequencies in another manner if the ITU plan is not nationally acceptable.

While the Third World's performance at the 1974 Conference may appear as a sort of immature nationalism, it has its roots in economics. The radio spectrum represents a capital asset to the LDC's. A valuable commodity to have, even if it presently remains unused. This asset could be turned into future cash flows by leasing the spectrum to other nations or by coaxing new business interests to settle within its boundaries due to the available frequencies for communications and data transmission. While much of the Third World's actions are purely political maneuvering for power at home and abroad, such economic issues are also important.

At the conclusion of the 1974 WARC, it was all too clear that the LDC's had the power necessary to pass or defeat any proposal at future WARC's.

A separate but related development occurred at the Sixth Special Session of the United Nations in 1974. The developing nations demanded a massive reallocation of the world's resources

to create a "new world economic order." Telecommunications were not specifically mentioned, but strong reference was made to setting the priorities for all types of assistance. The ITU's Secretary General hailed the Sixth Special Session as ".. a decisive turning point in the history of mankind and that of the ITU." He further stated that the ITU, "..welcomes enthusiastically the opportunity offered to cooperate, within the sphere of its competence, in implementing the establishment of a new international economic order."[28,p.2] These actions by the U.N. and the views of the ITU Secretary General added legitimacy to the demands of the Third World.

Another vital issue to the LDC's and sometimes the Soviet Union is a nation's alleged right to control information broadcasted across its borders from without. The newly emerging nations, for the most part, saw this control as a way of shielding their populace from outside propaganda during the usually sensitive period of early independence and development. The Soviet's support of these controls in the authors' view, is a direct reflection of its form of government, which requires control of the information flow to the masses. The 1977 WARC on Broadcasting Satellites became the forum for this issue when it was not addressed at the UNESCO conference of that year. The Conference accepted, in the 12 GHz band, technical interference standards that would effectively eliminate future transnational direct satellite broadcasting without the prior consent of the target country. This was strong political action as direct satellite broadcasting was still in the experimental stage. Satellites and receivers had not yet been developed which would

permit direct broadcasting by one country to conventional radio or television receivers in another country; or even in the same country. The U.S. delegation stated that it did not "explicitly" endorse this principal, and that its traditional position favoring free international flow of information had not changed, but without strong U.S. opposition the effect was the same.[66,p3] In addition to the adoption of the broadcast standards, the Conference ignored the U.S. argument that action assigning specific frequency orbital positions for satellites (geostationary type) should be postponed until the technology had been perfected. Consequently, Regions 1 and 3 countries were assigned portions of the spectrum which some of them may never be able to use.[66,p.5] Only the countries of Region 2 (the Western Hemisphere) were persuaded by the U.S. to delay this drastic action. However, the Region 2 countries, including the U.S., have committed themselves to confer again on this issue no later than 1982, most probably at the 1979 WARC. This principle of equal access established in 1974 and reinforced in 1977 is a demonstration of the Third World's ability to wield political power in international bodies. FCC Commissioner and leader of the U.S. delegation, Robert E. Lee's, remarks during the House Interstate and Foreign Commerce Subcommittee on Communications Hearings in May of 1977 typified the government's approach. He stated that the U.S. has always taken the position that the ITU is a technical rather than a political body, and that when political considerations arise, they should be submitted to the United Nations.[66,p.2] This approach fails to recognize the

realities of a numerically superior group of countries that will seek their perceived national interests in any forum available.

The historical trend is clear. The new technology of wireless communications was born almost a century ago. As it rapidly developed more and more uses became available through technological leaps. Each use provided economic benefits to the user. These economic benefits nurtured new technological advances. As the finite spectrum became increasingly saturated political action was necessary to provide equitable and efficient use of the resource. In reality ten percent of the world's population has controlled ninety percent of the world's telecommunications and it's associated economic benefits. The ninety percent of the world's population that has been without these benefits is flexing its political muscles in hopes of increasing its share. The U.S. must recognize and in fact be sympathetic to this trend if it is to remain the world's leader in telecommunications.

D. SUMMARY

In the earliest stages of frequency allocation the model operated around the periphery (marketing process) and the regulatory section was basically transparent. The authors' view is that the ageless American ideas of technology and a free market guided the process. As demand increased, technology dictated where new users would be located in the spectrum. The benefits were significantly greater than the associated costs and fueled further increases in demand. As noted in the history,

the period from 1957 to 1971 represented a transition phase. During that time the costs of spectrum expansion increased as users moved into higher bands. The benefits were still relatively great but the associated costs to other users began to rise rapidly. With the technological path becoming partially blocked by increased expansion costs the regulatory process took on more significance. It was during this period that international politics and economics began to have an ever increasing affect upon allocation decisions. The more the political path was used the larger the bureaucracy grew with its associated factors of negotiation politics, international conflicts and bureaucratic sluggishness. The allocation decisions of this period began the trend toward modification of existing spectrum as opposed to expansion.

Since 1971 the technological path has tended to be blocked to all but the most affluent nations. The U.S. has continued to pursue this path, virtually ignoring until recently the growing trend toward the political path. Because of this the U.S. has utilized purely technological strategies and only shown cursory interest in the other factors that affect the regulatory process. It is important to note that according to the model's operation as the technological path becomes blocked the internal factors of the regulatory process take on added importance. Today they are vital to any continued movement toward U.S. goals. It has been this U.S. attitude of refusing to recognize the importance of the regulatory process that has put us at a disadvantage in relation to the rest of the world.

The next chapter will examine this regulatory process in more detail.

IV. ENVIRONMENT

A. TECHNOLOGY

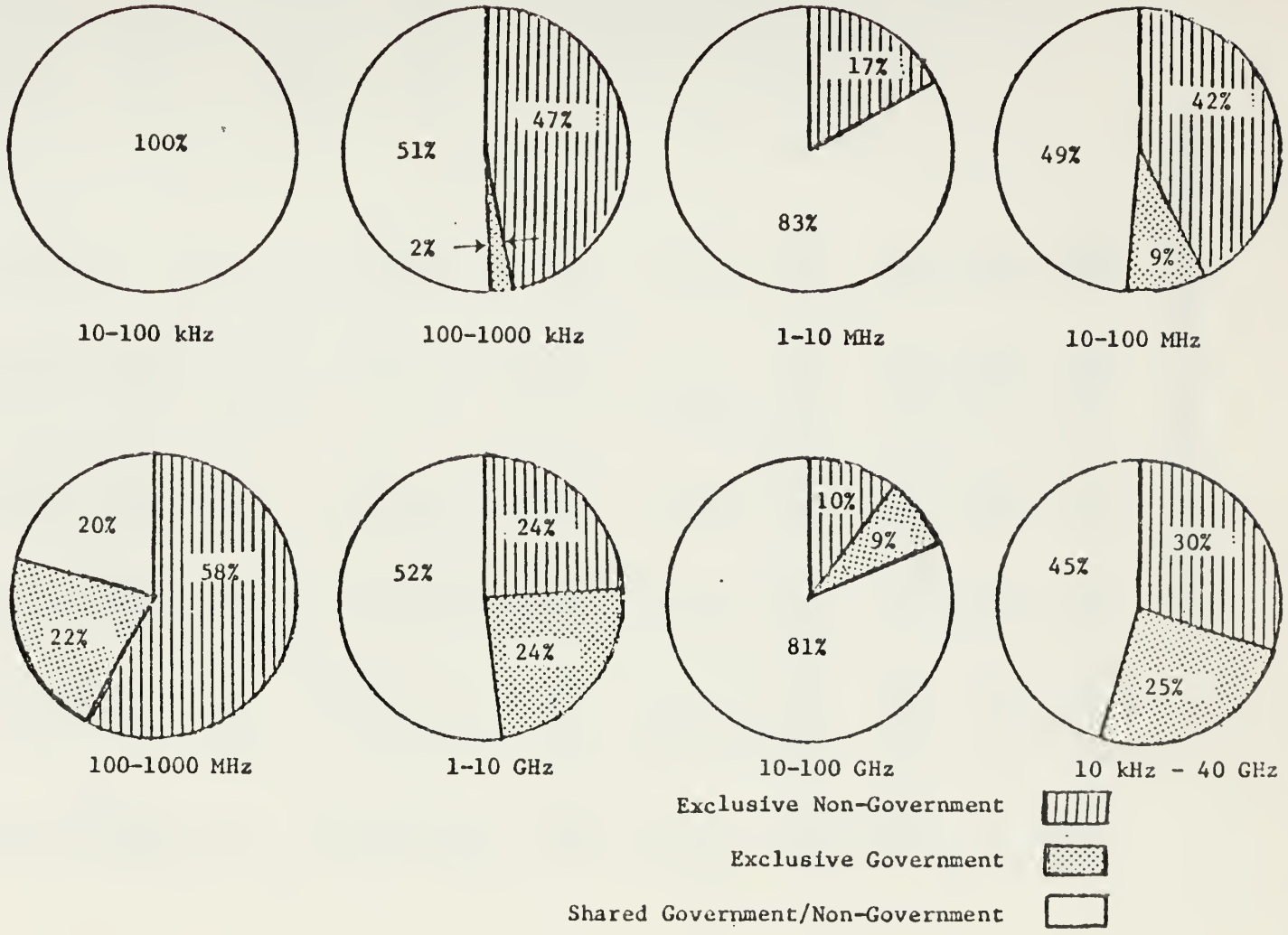
1. Present

Frequency usage within the U.S., or the provision and use of the services made possible by the radio spectrum fall into two categories; Federal Government usage and non-Federal Government use. Figure 2 shows the division of these frequencies. Federal government usage of the spectrum includes every Federal Agency. Figure 3 lists the percentage use of each Federal Agency. The Departments of Defense and Transportation utilize 65 percent of all government frequencies. The bulk of these, and therefore of all government use, can be classified as national security interests and safety of life interests.

There is also significant interplay between government and non-government uses. Non-Government ships and aircraft are served by Government radio facilities; Federal law enforcement agencies have communication links with state and local agencies; Federal power systems interconnect with non-Federal, and so forth. Additionally the Federal Government relies heavily on commercial systems through leased lines, AT&T, and leased satellite channels to fulfill its mission.

The government's interest in the present communications spectrum is formidable. The Department of Defense's expenditures for communications-electronic equipment are approximately $10 billion dollars a year, consuming 50 percent of the electronic industry's output. [54, p.D-8] The National Communications

DIVISION OF RADIO SPECTRUM BETWEEN GOVERNMENT AND NON-GOVERNMENT SELECTED FREQUENCY BANDS



(Ref. 54, p. D-2)

Figure 2

NUMBER OF GOVERNMENT FREQUENCY ASSIGNMENTS

	1- 1-66	1- 1-68	1- 1-70	1- 1-72	1- 1-74	1- 1-75
riculture	2,527	4,345	7,213	7,559	7,893	7,843
r Force	23,055	24,916	24,417	21,183	20,280	20,260
chitect of The Capitol	1	1	1	1	1	1
my	21,392	19,927	18,826	13,817	14,640	14,360
omic Energy Commission	1,983	2,763	2,400	2,292	2,762	
vil Service Commission						1
ast Guard - DOT	4,967	(5,868)	(7,523)	(8,737)	(8,634)	(8,872)
mmerce	2,200	2,595	3,223	3,979	4,089	3,866
nsumer Products Safety Comm						1
ergy R&D Administration						3,044
vironmental Protection Agency				67	139	146
deral Aviation Admin - DOT	18,340	(17,688)	(17,618)	(15,434)	(17,054)	(18,373)
deral Communications Comm	698	706	1,247	700	766	754
deral Energy Administration						1
deral Reserve System	15	22	32	49	68	70
neral Services Administration	46	50	58	110	199	199
vernment Printing Office					2	2
alth, Education & Welfare	163	250	252	293	699	729
use of Representatives						1
using & Urban Development		1	1	2	1	4
terior	6,385	6,943	7,878	7,261	8,166	9,226
t. Boundary & Water Comm	22	19	23	25	25	29
int Assignments		272	590	737		
stice	4,201	5,209	6,975	8,589	9,458	9,865
bor				18	21	21
brary of Congress	1	1	1	3	2	2
tional Aero. & Space Admin	738	895	952	1,071	1,120	1,078
tional Science Foundation	29	68	92	123	122	126
vy	21,122	22,083	21,371	20,691	19,113	19,565
n-Government				921	1,235	1,484
fice of Economic Opportunity	3	11	7			
fice of Emergency Preparedness				2		
fice of Management & Budget				1	1	2
lthsonian Institution	7	15	20	36	37	41
ate	17	58	68	87	94	94
preme Court				2	2	2
nnessee Valley Authority	442	488	542	617	761	789
nsportation (excl CG/FAA)		(119)	(154)	(156)	(169)	(200)
" Total		23,675	25,295	24,327	25,857	27,445
easury	834	1,142	1,101	1,197	1,365	1,508
S. Capitol Police	1	3	2	3	5	5
S. Information Agency	1,108	1,162	1,023	1,055	1,108	970
S. Postal Service	76	99	180	279	443	574
terans Administration	93	138	191	289	447	502
her	112	116	96	98	103	152
Totals	110,578	117,973	124,077	117,484	121,024	124,762

(Ref. 54, p.D-20)

Figure 3

System (NCS) serves 1930 locations in the U.S. and 1233 in foreign countries. Government owned radio facilities include high frequency stations providing voice channels and teletype, microwave systems and satellite links. All together, over 2,200,000 miles of voice channel and over 3,200,000 miles of teletype channel are supported by these facilities. The total number of government frequency assignments has grown from 110,578 in 1966 to 124,762 in 1975 to 140,000 in 1978. Because of the long distances generally involved, often over long stretches of ocean, the two types of radio facilities that are normally considered typical for international communications are HF and satellites. Because of its high volume of international communications, and the associated costs of HF spectrum saturation, the U.S. has come to rely on satellites and undersea cables for the vast majority of its international communications. As a result, use of HF radio for such services has declined substantially over the last decade, primarily because of the very limited capacity possible through HF radio circuits. The current U.S. proposals contained in FCC Docket 20271 [57, p.169] propose reductions of approximately 30 percent in the frequencies assigned to HF point to point service. These frequencies would be reallocated to broadcast services.

The trends in government usage are to higher frequencies that provide higher capacity and therefore an increased data to band width ratio. As developed by the International Communications Agency (ICA) and the Board of International Broadcasting (BIB), HF broadcasting requirements have also continually increased. The primary services, Voice of America (VOA), Radio

Free Europe (RFE) and Radio Liberty (RL) have grown from 400 frequency hours daily in 1950 to 2100 frequency hours daily last year. The number of transmitters has grown from 54 to 155. The rapid growth of HF broadcasting has placed much pressure upon the Federal Government to relinquish HF FIXED frequencies. While as stated previously the HF FIXED frequency usage has declined, it still provides the major method of redundancy for the more sophisticated microwave and satellite systems. Additionally microwave and satellite systems are susceptible to jamming and high maintenance costs.

The VHF, UHF and to some extent the SHF bands are rapidly becoming saturated. The military controls a huge portion of this band, with most tactical circuits within this range. The basic line of sight properties of this portion of the spectrum make it ideal for a number of different systems. The Federal Government's usage includes the Fleet Satellite Communications System of the Navy, 20,000 miles of microwave systems both local and national, doppler shift navigation satellite systems, instrument landing systems, telemetry and tracking and meteorological aids. [54, p.E-4]

On the non-Government side frequency usage has expanded as much if not more than the Federal Government. More than 800,000 applications for frequencies are received each year by the FCC. The largest non-Government user of frequency spectrum is the Broadcasting service. It reaches practically into every home and automobile and is allocated 372 MHz of prime spectrum space, 40 percent of the frequency band 30-960 MHz. Sixty percent of the space in that band is allocated exclusively to

non-Government use. It has the largest public capital investment of any radio service, an estimated $32 billion dollars in 368.6 million AM and FM receivers and 109.8 million TV receivers. Television revenues alone are $5 billion dollars a year. The number of broadcasting transmitters grew from 25,557 in 1970 to 29,131 in 1973 alone. [54,p.D-36]

Land mobile services and citizen band radio have also expanded rapidly. Commercial microwave systems transmitters have increased by 500 a year since 1970, while COMSAT and other earth terminals have added to the rapid increases in spectrum usage. [43,p.237]

Microwave growth has also been significant. The communications common carriers of the U.S. have in excess of 60 million miles of individual telephone channels and about 100 thousand miles of television video transmission channels. In addition there are the private uses of microwave (railroad, pipeline, utilities) covering another 50 thousand miles. [43,p.237] The demand for microwave frequencies continues to be high, especially in urban areas where its short line of sight properties and low interference ratio can be utilized.

Television Broadcasting historically was concentrated in the allocated VHF frequencies with only sparse development of the UHF spectrum. The large profit producing characteristics of television have now placed all TV allocated spectrum at a premium. The advent of cable television systems has allowed UHF stations to reach out to ranges equal with the VHF stations and in the the authors' opinion, the increasing demand for more UHF spectrum will continue.

From the U.S. standpoint saturation exists in all bands below 30 GHz.[54,p.D-8] Only good management and advancing technology enable the efficient use of the many diverse services.

The developed countries of the world have followed the lead of the U.S. to higher frequency, higher capacity systems utilizing our available technology. Some differences in emphasis exist, however, due to geographical considerations. The European countries have a regional satellite system and also some domestic satellite coverage. The close proximity of borders has resulted in an increased reliance upon microwave systems for internal communications. The proximity problem also necessitated large capital outlays by some countries, most notably Britain in under sea cables, which slowed their move to satellites. Nevertheless, satellite system increases are still formidable, with 7,000 circuits in the Atlantic Ocean region by the end of 1977.[57,p.71]

Even with the competition from other systems the growth of satellite service has been significant. Intelsat, the International Satellite consortium has opened high speed and high capacity communication to many countries which previously were unable to afford the technology. Between 1967 and 1969 Intelsat II Satellites were launched in both the Atlantic and Pacific ocean regions. These second generation satellites provided 240 voice circuits, permitting 240 subscribers on one continent to speak simultaneously to 240 subscribers on another continent, thereby introducing an important distinction from transoceanic cable facilities - the ability to have multiple destinations transmit and receive simultaneously; a cable

connects only two points. The Intelsat III series extended satellite communications to the Indian ocean region and increased the capacity to 1500 telephone circuits. This large increase permitted use of the system for transoceanic television service on a non interruptable basis. The Intelsat IV series, placed in orbit between 1971 and 1975 provided a capacity for 4000 telephone circuits and two additional television channels. The Intelsat IV A series launches are presently in progress, increasing the capacity to 6500 circuits.[57,p.65] Thus satellite communications are available to all nations.

HF FIXED circuits have declined worldwide just as in the U.S. with a corresponding increase in the demand for HF Broadcast circuits, primarily in the tropics and for maritime use. While the declining trend of HF FIXED service is a fact, bilateral discussions with a number of countries reveal a continuing need for significant numbers of HF FIXED systems for domestic and regional networks.

The importance of communications internationally can be shown by the Department of Commerce's latest statistics contained in reference 37.

1. Germany - Total consumption of electronic components for 1977 was $1.7 billion.
2. Japan - Market research for 1977 indicated a telecommunication market of $640 million dollars.
3. Mexico - A total market of $448 million for telecommunication equipment.
4. France - Modernization of the countries telephone system to incorporate microwave/satellite technology.

It is clear that with the availability of technology and international assistance the communications systems of the world are becoming more and more sophisticated, with respect to higher data transmission rates. The overall result is a shortage of available frequency spectrum in the already crowded HF Broadcast, television, microwave and satellite bands. The demand for this finite resource continues to increase.

2. Future

The United States will continue in the authors' view, to expand its HF broadcast requirements and reduce its HF FIXED assets, but the need for redundant military HF systems will remain at least until 1990.

By 1985 over 7500 earth terminals will be needed in the U.S. to provide 300,000 voice ports. The Commerce department estimates electronic goods sales will reach $40.2 billion by 1983 while TV revenues will approach $5.3 million. [47,p.4] FCC authorized transmitters in the Safety and Special Radio services, assuming sufficient frequencies are available, will reach 18.4 million. Simultaneously, the Federal government equipment inventory will be valued at $60 billion. [47,p.5]

While technology has created and encouraged the desire for additional uses of the spectrum it has also provided methods to cope with the associated problems of the increased demand. High capacity cables, fiber optics, lower bandwidth separation, directional systems and bit packing techniques are just a few of the new methods that will act to alleviate the saturated conditions of the frequency spectrum. The overall effect is to increase supply. This increase continues to lag behind the growth of demand.

Through INTELSAT and the multinational corporations, high capacity sophisticated communications systems are becoming available worldwide. Countries that previously relied upon antiquated (by US standards) systems, due to a lack of technological skill or a shortage of the enormous capital investment required for modern systems are now planning to lease or rent sophisticated systems. In the authors' opinion, the next twenty years will see all countries of the world obtaining satellite access and modern domestic communications systems. The next generation of Intelsat satellite (Intelsat V) will have a capacity of approximately 12,500 telephone circuits, double the capacity of Intelsat IVA. [57,p.65] Planned regional and domestic satellite communications markets around the world will create a $2 billion non-US earth station market by 1990, according to Frost and Sullivan forecasters. [11,p.43] Most important among these are five regional systems in a planning stage and three foreign domestic systems already in operation.

The first regional system to be operational will be ARABSAT this year, a two satellite system with a 2000 voice circuit, 4 TV circuit capacity each. A European system, the European Communications Satellite (ECS) is also in the planning stage. It will provide an operational network to member nations with 5000 voice channels in 1980 and 20,000 by 1990. Other regional markets include SERLA, the Regional System of Telecommunications in Latin America and the Association of South East Asian Nations (ASEAN) system. [11,p.43]

The final identified regional system is Africa. The present telecommunications network in Africa is in its early

stages of growth. Numerous satellite broadcasting systems for countries south of the Sahara have been proposed in recent years. While no specified plan has been adopted, experts predict that Africa may represent the largest earth station market of the 1990's.[11,p.43]

With FIXED Satellite service firmly entrenched in the spectrum, its mate, direct Satellite Broadcasting is nearing reality. A long sought after system that is only now becoming technically feasible and affordable, direct satellite broadcasting could bring satellite communications into each home on a worldwide basis. Direct systems are already planned for Germany, France, Italy, Norway, and Sweden. Most of these will be completed during the 80's. [29,p.91]

Direct Satellite Broadcasting brings with it other problems than more saturation of the spectrum. These are discussed in a later section.

Another medium that must be included in future trends is the further development of undersea cables. Another transatlantic cable is planned for 1981 with an additional 4000 circuit capacity. While cables are viewed by some as an archaic means of communication, they provide diversity and therefore add to the overall efficiency of a communication network. The European community, especially, views cable systems as a viable alternative to the risk of high cost satellite outages.[57,p.72]

With 94 nations participating and some 80 percent of the world's overseas traffic going by satellite, the trend is clear. Domestic traffic and services to mobile platforms will probably represent the greatest portion of satellite traffic ten years

hence. The satellites will continue to exploit the solid state revolution so as to permit increasingly complicated communications.[29,p.89] One can expect on board message switching and processing in great quantities. In the authors' view, the military organizations of the U.S. and other countries and groups will expand their satellite activities so as to exploit the spectacular tactical possibilities. Digital technology will predominate in future development. Broadcast satellites, long possible technically but politically sensitive, will slowly come into their own due to antenna techniques used to restrict useful signal levels to within a national boundary. The ability of NASA's space shuttle to launch large payloads will make the exploitation of all the techniques easier.

B. POLITICAL TRENDS

Rapidly expanding telecommunications technology has provided untold benefits to the world community. Educational services, health information distribution, and scientific information sharing are just a few of the many missions telecommunications has fulfilled. It is inevitable however, that telecommunication technology should also have its political realities.

In simplistic terms the world community can be classified into three groups; The Western-bloc lead by the U.S., the Soviet-Warsaw bloc and the so called non-aligned bloc.[64,p.44] They can also be classified as the rich and poor with the first two in the former category and the non-aligned bloc in the latter. This large group of nations called non-aligned (also referred to as Lesser Developed Countries or LDC) have only recently become

a force on the political scene. They were almost entirely born out of the old colonial empires, most notably the British Empire. [64,p.43] As such these countries have many political commonalities; most adhere to socialistic principles and are inherently suspicious of the developed countries of the world both East and West.

In a sense these LDCs are a paradox. They are lacking in technological skills and economic resources but control many of the natural resources utilized by the more powerful developed nations. During the early stages of their recent history, fierce nationalism and political instability prevented them from making their voices heard in the world's international organizations. To a large degree the developed countries continued to treat the LDC's as if they were still colonies. Due to their poor economies the LDC's were forced to trade these natural resources for the basic necessities of life at terms dictated by the developed nations.

Realization of the LDC's political power began modestly enough as UN delegates of non-aligned countries pooled their votes, thus enabling them to force acceptance of their resolutions in the General Assembly. It wasn't long before regional conferences established organizations to forward the interests of the LDC's. The result is that much political power is in the hands of LDC's as a whole. As an example, Algeria could not force spectrum concessions from the developed nations, the LDC bloc can. The political power of the LDC's is particularly effective in organizations that adhere to the one-country, one-vote rule. These include all UN organizations of which the ITU is one.

In order to describe the political trends it is necessary to examine the state of telecommunications as viewed from the eyes of the developed countries and the LDC's.

The developed countries presently control all the economic power of telecommunications. Through Government actions, they control the communications-electronics industry of the world and therefore the technology. Moreover they control INTELSAT; the US alone has a 53 percent voting block.[34,p.58] Additionally, even though they represent only ten percent of the worlds population, the developed countries are allocated ninety percent of the spectrum. Thus telecommunications provide a significant economic resourse for the developed nations. It is also vital to the developed nations maintenance of worldwide interests and influence. One has only to surmise the effect a loss of communications circuits would have on the US command and control system to appreciate the importance of the possessed spectrum.

Since the developed countries can only maintain their standards of living and influence by continued growth, these nations view the LDC market as a means to this end. It is the opinion of the authors that it is economically and politically advantageous to assist the LDC's in the development of modern telecommunications; economically, because of the revenues this assistance will generate and politically, because of the increased influence to be gained.

It would be a comforting thought that the developed nations of the world are helping their poorer brothers to reduce poverty and improve the lot of the world community. Realistically if

humanitarian principles were stripped away, assisting the LDCs in a bootstrap effort could increase world stability while it continues to expand the markets of the developed countries.

The perception of the situation from the LDC's viewpoint, is markedly different. The predominantly socialistic governments of the LDC's have a well documented adversion for anything giving the appearance of colonialism.[64,p.43] They follow the socialistic principles of redistribution of wealth which views profit as synonomous with exploitation.

The LDC's therefore see modern telecommunications technology as their just right and the radio frequency spectrum as a world resource to which they are entitled free access. This conclusion is drawn from recent history. The LDC's arguments for a more equal footing in telecommunications directly parellels those they make in demanding acceptance of a so called New World Economic Order. They have used the United Nations as the principal forum for advocating their case for greater access to technology, capital, and resources that they see as unfairly monopolized by the more developed nations, particularly the former Western colonial powers.[64,p.44]

During the Cold War period, the USSR regularly attacked the West in general and the United States in particular. The split along East-West lines consumed more than its fair share of conference time at both the United Nations and the ITU.[6] The difference today is that in the past the U.S. knew from where these attacks would be coming and also had the votes to carry its positions. Now the Third World is the opposition and they have the votes (without technical expertise) to prevail.

Modern, sophisticated telecommunications systems in the hands of a newly independent or lesser developed nation are a source of national pride and also strong weapons in the struggle for political and economic survival. The pride comes from the possession of an advanced technology system. These systems can be a means of informing or controlling the population through broadcasting. A nation with worldwide communications access can make its voice heard and make itself more appealing to foreign investors. Access to these systems and spectrum space is a source of revenue for the LDC's, a fact they have realized and are exploiting. The LDC's feel they have the political power to gain this access now on their own terms. These terms include control of broadcast content by nation, frequencies utilized, and increased technical and financial aid for telecommunications systems.

The LDC's have been unhappy about the dominance of Western news organizations in coverage and dissemination of world news. [35,p.1] They feel that too little attention is given to LDC's and that what news is carried tends to be unfavorable and unfair to them. At the biennial meeting of UNESCO at Nairobe in 1976, at the specialized WARC in 1977, and at the non-aligned Broadcast Conference at Sarajevo, Yugoslavia in 1977 resolutions were presented that would give governments greater control over news generated and consumed within their own boundaries. In all cases action was delayed, but a unified stance is only a matter of time. The post colonial feeling of exploitation runs deep. [35,p.3] Though not mentioned specifically in the conference documents, (BROADCAST CONFERENCE) there were repeated references

by delegates during post-conference public statements to the need for their respective countries to cut back on the importation of "western films" for television broadcasting and to expectations of significantly greater assistance to the broadcasting organizations of the non-aligned by UNESCO (funded by the DEVELOPED NATIONS).[35,p.1] Reasons given for the former included allegations that such films are too heavily western culture laden, and that their ready availability tends to inhibit more costly domestic film production. Also noted was the fact that, in constantly exposing the people of their countries to a western standard of living, with which their governments may never be able to provide, they may be inherently destablizing politically.[35,p.2] The INTELSAT television usage figures substantiate the dominance of western broadcasting. Countries having greater than 50 hours per person per year of television usage were in diminishing order, the following: Spain, USA, Venezuela, Brazil, Peru, Japan, Italy, Argentina, Germany, Colombia, UK,, Australia and France. The developing countries in this list, however, had substantially more "receive" than transmit time, while the top five television transmit countries were Spain, USA, Australia, UK and Italy.[34,p.130]

The evidence of how much influence western broadcasting has on a developed nation's culture is less compelling. To illustrate this point, figure 4 lists the Intelsat member countries with the number of telephones per capita. This list shows an extreme of from 64.98 per 100 to 0.06 per 100. Further, 29 out of the 74 countries for which data are available have less than 1.50 phones per 100. Such a contrast shows the relatively

SIGNATORY	TELEPHONES PER 100 POPULATION	SIGNATORY	TELEPHONES PER 100 POPULATION
Algeria	1.28	Liechtenstein	49.52
Argentina	7.17	Luxembourg	32.68
Australia	31.18	Malagasy Republic	0.39
Austria	19.29	Malaysia (Approx.)	1.50
Barbados	11.16	Mauritania	Not Available
Belgium	20.83	Mexico	2.97
Brazil	2.17	Monaco	64.98
Cameroon	Not Available	Morocco	1.08
Canada	45.23	Netherlands	26.00
Ceylon	0.50	New Zealand	44.14
Chile	3.78	Nicaragua	1.29
Republic of China	2.75	Nigeria	0.12
Colombia	4.54	Norway	29.41
Costa Rica	3.48	Pakistan	0.18
Denmark	34.42	Panama	Not Available
Dominican Republic	1.15	Peru	1.61
Ecuador	Not Available	Philippines	0.81
Egypt	Not Available	Portugal	7.76
Ethiopia	0.18	Saudi Arabia	Not Available
France	17.19	Senegal	Not Available
Gabon	1.36	Singapore	7.78
Germany	22.43	South Africa	7.06
Ghana	0.68	Spain	13.56
Greece	11.96	Sudan	0.29
Guatemala	0.77	Sweden	55.67
India	0.23	Switzerland	48.26
Indonesia	0.17	Syria	1.84
Iran	1.06	Tanzania	0.27
Iraq	1.24	Thailand	0.42
Ireland	10.44	Trinidad & Tobago	5.51
Israel	17.47	Tunisia	1.50
Italy	17.38	Turkey	1.62
Ivory Coast	Not Available	Uganda	0.31
Jamaica	3.66	U.K.	26.68
Japan	25.14	U.S.	58.35
Jordan	1.30	Vatican City	Not Available
Kenya	0.70	Venezuela	3.90
Korea	2.01	Viet Nam	0.19
Kuwait	9.08	Yemen	0.06
Lebanon	6.78	Yugoslavia	3.57
Libya	2.08	Zaire Republic	0.11
		Zambia	1.30

(Ref. 34, p.132)

Figure 4

minor impact which INTELSAT satellites have created in terms of affecting the mass culture of INTELSAT member countries with relatively underdeveloped economics, particularly when it is realized that the availability of television sets is far more restricted. Thus, for countries with developing economies, INTELSAT in most cases has only affected the economic elite.[34,p.33]

While at times the LDC's present a unified stance there still exists no clear consensus on all issues. It is therefore predictable that at least for the near future sound technical reasoning and self-interest will influence the political stance of individual LDC's.

C. FREQUENCY ALLOCATION BY THE ITU

As previously noted not all frequencies are suitable for telecommunications services. Over the years the spectrum has been divided into bands. These bands are then allocated to the type of service for which they are best suited. The ITU allocates a given frequency to a particular station or service.[54] The respective government then regulates the location, time of use, and strength of each station. A problem can arise with adjoining countries; because of the overcrowding of the spectrum, neighboring nations are sometimes, unavoidably assigned the same frequency, thus making interference almost unavoidable. To counteract the interference, the response has been to install and use more powerful and more expensive transmitters and receivers. As one can readily observe a vicious cycle is started.

International Broadcasting has grown rapidly since World War II and is a point of serious contention in the radio spectrum deliberations. The United States used international broadcasting

in its Voice of America and Radio Free Europe/Radio Liberty broadcasts. The legitimate sanctioned broadcasts would be very adequate to reach their intended audiences were it not for the interference problem. The Third World wants to expand its international broadcasting for political recognition and prestige and to reach expatriates in the developed countries. Not having ITU allocated frequencies for international broadcasting, the LDC's now use aerial mobile and radio navigation bands on a "not to interfere" basis.

In the developed countries technology has eased the HF communication burden somewhat. The United States and other developed countries are increasingly relying on communications satellites, undersea cables, and terrestrial microwave systems for point to point non-broadcast communications traffic.[43] Using these systems for telephone, telex, facsimile, and data transmission, frees 30 to 50 percent of the fixed broadcast spectrum from its traditional use.[1,p.2]

The crux of the spectrum allocation problem is how to equitably allocate the freed spectrum to other services. The LDC's even though using some of these frequencies illegally, will not be willing to relinquish them. The LDC's rely on them for domestic and international communications. This use of non-broadcast frequencies for broadcast purposes only perpetuates and magnifies the interference factors.

Those trying to receive the United States broadcast signals find it difficult to do so. In order to have a high probability of reaching their audience, United States broadcasters must use three different frequencies. If the interference could be

reduced this would allow a reduction in duplication of signals freeing more frequencies for reallocation. This is a perfect example of how the benefits of cooperation could produce a mutual gain situation for all concerned parties.

D. WARC 79 PREPARATIONS

1. U.S.

The foregoing is the backdrop for the international forum (WARC 79) to be held late this year. In keeping with the historical facts, and the technical and political trends, the U.S. government has set forth the following internal negotiating guidelines which were approved by IRAC and the FCC. [57,p.221] These are;

a. Flexibility

To maintain flexibility to meet the future needs of users in telecommunications matters (Domestic and International) within the framework of the International Radio Regulations.

b. Minimal Change

Changes to the Radio Regulations should only be those that are absolutely required in order to meet the needs of users.

c. Defendable Positions

Proponents of new requirements should be in a position to defend the required revisions of the Radio Regulations, using sound and fully developed technical arguments.

d. Accommodate World Needs

Negotiations should take into account changes advanced by other nations and these changes should be resisted

only when they impede our national flexibility to an unacceptable degree.

e. Point of No Return

Where it is apparent that changes to the Radio Regulations, including modified allocations, are likely to be opposed, negotiators must have final fall-back positions.

It is logical that all proposals have first and foremost a technically sound foundation. It should also be clear that just as the foundation of a house is only a secure footing for the structure, so too must a sound political and economic policy be built upon solid technical foundations for the conference. Only in this way will the final structure be well built, lasting and comfortable for the world community that must abide with it.

The preparations within the U.S. have spurred much debate. Each federal agency, industry and private interest group involved have for the most part sought advantages for themselves while protecting their past gains. Since in the aggregate this is impossible the final U.S. positions are compromises.

These preparations are a microcosm of how the WARC negotiations will proceed. Each administration desires those changes advantageous to itself and rejects those it sees as detrimental to its interests. The final product, like the house noted above, must evolve from some compromises that detract as little as possible from the stability of the structure.

Preparation of the U.S. proposals to be sent to the International Telecommunication Union (ITU) is the joint responsibility of the National Telecommunications and Information Administration (NTIA) and the Federal Communications Commission.

The Government's requirements are being developed in the Ad Hoc 144 group of the IRAC (Interdepartment Radio Advisory Committee).[40,p.2] The FCC is determining the public's desires by issuing Notices of Inquiries (NOI's). At present, there are many working groups within which the government's needs are being coordinated with the public's desires. The following paragraphs explain who is contributing what at each point.

In the sub-groups of Ad Hoc 144 Committee, each Federal agency provides their senior technical personnel in spectrum management who both present their agency's requirements and participate in the negotiating process resulting in first draft proposals designed to satisfy those requirements.[40,p.2] All proposals developed in the sub-groups of Ad Hoc 144 are reviewed again by the full Ad Hoc Committee and once again by the full IRAC. At this level Federal agency participation is through the senior individuals in the spectrum support and policy areas. These individuals are qualified to ascertain whether generated proposals will meet foreseen, often congressionally mandated, programs and provide the necessary flexibility to allow the exercise of agency program options. If any agency's long range programs and/or policy options are adversely affected by the developed proposals, these senior staff personnel so advise the directors of their agencies.

In like manner, the Radio Service Working groups each provided delineation of their requirements to the FCC. The four FCC functional committees meld those statements of requirements into a set of draft Commission proposals for review by the FCC steering committee. Representatives of the International

Conference Staff in the International and Operations Office of the Commission meet with Ad Hoc 144 (and with all of its subgroups) so that both the Government and non-Government requirements are being continuously considered and the set of proposals being produced is, in fact, a draft U.S. National position.

After review and approval by the IRAC and FCC steering committee, the proposals are issued to the public in the form of Notices of Inquiry in Doc. 20271. Thus, while the NTIA and the IRAC are reviewing the proposals for National policy and agency policy implications, the general public, the industry, and state and local governments, are reviewing those same proposals in FCC Notices of Inquiry. Comments and reply comments submitted to those Notices of Inquiry and further inputs from the Federal agencies through this same Ad Hoc 144 process then result in the next iteration of the developing proposals. Policy review is effected from an agency standpoint in the IRAC. Policy review from the National Telecommunications Policy standpoint is effected by the Director of Spectrum Plans and Policies in NTIA and by the FCC Commissioners at the time they consider and approve the release of the Notices of Inquiry.

When the finally developed recommended U.S. position is jointly and simultaneously presented by the FCC and NTIA to the Department of State for adoption, it will receive a final review from the standpoint of foreign policy. This review should, however, be a very simple matter since the State Department's Representative to the IRAC comes from the Office of International Communications policy, in the Bureau of Economic Affairs, and

foreign policy considerations have been continually examined throughout the entire preparatory process.

The two principal players in these preparations are the FCC and the IRAC. The Federal Communications Commission is an independent Government agency responsible directly to Congress. It was established by the Communications Act of 1934, and is charged with regulating interstate and international communications by radio, television, wire and cable. The regulatory powers of the Commission were expanded by the Communications Satellite Act of 1962 which gave the FCC authority to regulate U.S. portions of satellite systems.[54,p.C-13]

The FCC is directed by seven Commissioners, appointed by the President and confirmed by the Senate for 7 year terms. One commissioner is designated the chairman. As the private sector's advocate in the preparations, the FCC represents not only the general public but also the broadcast industry, amateurs, the electronics industry and local governments.

The Interdepartment Radio Advisory Committee (IRAC) was organized in 1922, upon invitation of the Honorable Herbert C. Hoover, then Secretary of Commerce.[35,p.1] Secretary Hoover acted in response to a suggestion by the Chairman of the First National Radio Conference, Washington D.C., that interested government departments designate representatives to a committee with an objective being to find means for making the most effective use of the spectrum then used by the government. The IRAC's mission has been broadened over the years to include all interdepartment radio matters and to advise the President with respect to frequency assignments for the government. Figure 5 is the preparation process for WARC 1979.

National Preparatory Process for WARC '79

Federal Government Requirements

FEDERAL AGENCY RADIO FREQUENCY MANAGERS (IRAC MEMBERS)

- AGRICULTURE
- AIR FORCE
- ARMY
- COAST GUARD
- COMMERCE
- ENERGY
- FEDERAL AVIATION
- GENERAL SERVICES
- HEALTH, EDUC., WELFARE
- INTERIOR
- INT'L COMMUNICATIONS
- JUSTICE
- NAT'L AERONAUTICS & SPACE
- NAT'L SCIENCE FOUNDATION
- NAVY
- STATE
- TREASURY
- VETERANS
- FEDERAL COMMUNICATIONS COMMISSION – LIAISON

Fiegelson NAVY — 10KHz – 27.5 MHz (Ia)
Torok FCC — 27.5MHz – 1215MHz (Ib)
Bradley NTIA — 1215MHz – 10GHz (Ic)
Kimball NASA — 10GHz – 300GHz (Id)
Urbany NTIA — Notify/Coordinate Registration & Definition (Ie)

Coordinations Notifications Allocations Definitions
Bass NTIA — I Operations
Fisher FCC — II Technical
Marsh ARMY — III Delag Support
Mayher NTIA — IV R.R. Rearrangement
John NTIA — V

AD HOC 144 Probst CHR

IRAC Probst CHR

SECRETARY OF COMMERCE
ASSISTANT SECRETARY COMMUNICATIONS & INFORMATION
Geller
ADMINISTRATOR NTIA Geller

DIRECTOR SPECTRUM PLANS AND POLICIES Probst

ASSOC. ADMIN. FSSM Jansky

U.S. POSITION COORDINATION

SECRETARY OF STATE
DEPUTY SECRETARY OF STATE
Christopher
U.S. DELEGATION Prof. Robinson

INITIAL DELEGATION GROUP WARC 1979

FORMAL U.S. POSITION

CHAIRMAN FCC Ferris
THE COMMISSIONERS

TO PUBLIC

FCC NOI

NTIA/FCC COORDINATION

FCC LIAISON

Public and State Government Requirements

RADIO SERVICE WORKING GROUPS – including PUBLIC INTERESTS

- COMSAT
- RADIO RELAY
- DOMESTIC LAND MOBILE
- HF FIXED
- RADIO ASTRONOMY
- AMATEUR
- LAND MOBILE
- MARITIME
- AVIATION
- INTERNATIONAL MONITORING
- TV BROADCAST
- AM/FM BROADCAST
- SPACE BROADCAST
- INTERNATIONAL BROADCAST
- BROADCAST AUXILLIARY
- O/E PROCEDURES
- INSPECTIONS
- INFRACTIONS
- OPERATOR LICENSING
- MISCELLANEOUS

STATE GOVT REQTS

PUBLIC INTEREST GROUP REQTS

INDUSTRY REQTS

I & O – INT'L CONFERENCE STAFF

ADVISORY INPUTS

LEGAL AND POLICY

FCC STEERING COMMITTEE

ALLOCATIONS AND REGULATIONS

FREQUENCY REGISTRATION AND INT'L FREQUENCY LIST

TECHNICAL

OPERATIONS

PUBLIC REPLY

Figure 5

The Federal Government has the responsibility for frequency management, as well as establishing national objectives and executing those policies. Its functions also involve the management, supervision, and regulation of spectrum usage to minimize conflicts and satisfy the country's communication requirements. As stated before this responsibility is divided between the NTIA (Department of Commerce) for the Federal Government and FCC for private enterprise.

The FCC and the NTIA are charged with the bulk of the preparation for the 1979 WARC. The State Department represents the United States at all ITU conferences, forwards letters to the Chairman of the FCC, and appoints and accredits the United States delegation to ITU conferences. The State Department also coordinates United States proposals and provides regular representation on the ITU Administrative Council. This council carries on the working of the ITU between conferences. In addition the State Department provides the chairmanship of the United States National Preparatory Committee of the International Radio Consultative Conference (CCIR).

Once conferences are completed the State Department forwards the International Radio Regulations to the Senate for its advice and consent. Because the International Radio Regulations are treaty obligations they must be ratified by a two-thirds majority of the Senate and signed by the President.

Assisting in preparation of coordinated technical proposals is the Interdepartment Radio Advisory Committee (IRAC) The IRAC is chaired by the Assistant Secretary of Commerce for Communications and Information. The IRAC consists of 18

Federal Agencies plus the Department of State, United States Information Agency (USIA), military services, National Aeronautics and Space Administration (NASA), Department of Treasury, and Department of Commerce. The IRAC has a permanent liaison with the FCC. To carry out its functions the IRAC has permanent sub-committees and forms Ad Hoc groups for special cases. Ad Hoc 144 is doing the bulk of the preparations for the 1979 WARC.

Ad Hoc 144 has established the following subgroups:

Ad Hoc 144-I - Prepare for consideration by Ad Hoc 144 the draft of U.S. positions regarding the definitions, allocations, notification, coordination, and registration provisions of the International Radio Regulations. The subgroup is subdivided with regard to the services contained in the International Table of Frequency Allocations.

Ad Hoc-144-II - Prepare for consideration by Ad Hoc 144 the draft of U.S. positions regarding the operational and procedural provisions of the International Radio Regulations.

Ad Hoc 144-III - Prepare for consideration a draft regarding technical provisions of the International Radio Regulations. This subgroup recognizing the need for consistency of effort has invited participation by the U.S.CCIR. Each U.S.CCIR study group has designated representatives to Ad Hoc 144-III to identify technical questions which need to be addressed within CCIR and maintain consistency in technical planning being undertaken by both CCIR and government participants in AD Hoc 144.

Ad Hoc 144-IV - Was established in early 1976 to assist in eliminating redundant efforts among government agencies, particularly in the application of automatic data processing expanded to

include the identification of support facilities which may be required by the United States delegation in Washington D.C. and the Conference site.[64,p.32]

Ad Hoc 144 and the U.S. CCIR are charged with developing recommended government proposals, commenting on foreign proposals when available, assisting in preparation of United States positions, and planning for United States implementation of the final acts of the conference. "Proposals" are defined as suggestions for changes in the International Radio Regulations which the United States will forward to the ITU, while "positions" are papers the delegation will bring to the conference. These papers will spell out for the delegates the degree of negotiating flexibility they will have in trying to achieve the United States proposals and positions vis-a-vis foreign proposals.

In carrying out its responsibility the FCC has established an internal steering committee as well as a structure of Service Working Groups for the private sector. The FCC Office of the Chief Engineer (OCE) is one of its major operating bureaus. The OCE participates in all technical aspects of international telecommunications activities. The Assistant Chief Engineer (International and Operations Division) is responsible for OCE frequency management activities. This office has been designated the FCC Liaison Representative to the IRAC and works directly with the NTIA, IRAC, and Executive Branch agencies on matters of mutual concern, including the 1979 WARC. The NTIA also receives advice from the Frequency Management Advisory Council (FMAC). The FMAC is a group of private electronic industry leaders.

The 1979 WARC agenda may contain only items determined in advance by the ITU Administrative Council with the concurrence of a majority of the member countries involved. This rule, in effect for all past WARC's, has been modified for the 1979 WARC. A special resolution was adopted by the new majority in the ITU that will allow the agenda for the 1979 WARC to be revised by the participants following the opening of the conference. The agenda items and positions on these items for the United States are developed by the NTIA using the IRAC/FCC mechanism to coordinate a unified approach. Once agreement is reached on these items they are forwarded to the State Department for use by the United States representative to the ITU Administrative Council.

When the State Department receives any approved agenda item from the Administrative Council it transmits the item to the NTIA. The NTIA then develops positions and instructions, with IRAC/FCC participation for the United States' delegation. The NTIA conducts an exchange of "Preliminary Views" on each agenda item through meetings with other ITU members. The FCC will issue several "Notices of Public Inquiry" to solicit inputs from private interests and the telecommunications industry. The NTIA/FCC then jointly develop United States proposals, alternative positions, and instructions for the State Department to forward to the United States delegation. Internal to the State Department these matters are handled by the Office of International Communications Policy in the Bureau of Economic Affairs. This Office is responsible for final modification of proposals to insure conformity with United States foreign policy objectives.

Among communication and diplomatic professionals there is much apprehension over the current state of American policy.[57,p172] With the deletion of the Office of Telecommunication Policy from the Executive Office of the President and its functions shifted to the NTIA at the Department of Commerce there is great concern that the government's representative cannot compete effectively with the more independent and powerful FCC. There is fear that the interests governed by the FCC - the private telecommunications industry - might acquire undue influence in the policy process by which WARC positions and proposals are developed, and that this could conceivably work to the detriment of United States national interests.

The concern over apparent inaction in preparation for the 1979 WARC reached the House of Representatives Communications Sub-Committee of the Interstate and Foreign Commerce Committee.[49,p.3] They voiced fear in May 1977 that the United States had not begun its planning early enough and was far behind schedule in naming delegates. Also under question was the composition of the United States delegation and its potential viewpoints on various positions and proposals. A number of Subcommittee witnesses stressed the importance of including minority, women, and non-technical representatives in the delegation in order to increase United States' sensitivity to Third World and consumer considerations, as well as political, social and cultural factors that government engineers and telecommunications industry representatives might overlook or underplay.

The State Department responded that certain preparations were already underway. Preliminary consultations with foreign

governments on possible agenda items were in progress and national positions for the conference were being prepared. State Department witnesses testified that "full and serious" considerations were being given to female and minority members while applying the standard of "essentiality" to keep the group as small as possible.[7,p.15]

The Ad Hoc 144 group and its subcommittees have since been holding meetings, and the FCC has issued Notices of Inquiry to stimulate public discussion.[7,p.17] The FCC notices have been controversial, however. The Fifth Notice has been characterized as too technical for the public to read and understand, therefore of limited use in facilitating or encouraging public participation. Critics also charge that important questions are not being addressed in the Inquiries.

The United States is unique in the arena of telecommunications because of its large private sector.[54] Therefore, the United States delegation will be representing the interests of both the public and private sector in telecommunications matters at the 1979 WARC. Most other nations have publicly owned government monopolies - usually Postal, Telephone and Telegraph (PTT) Ministries. These ministries are able to speak with a single voice for their governments. The foreign Governments are thus able to formulate telecommunication policies without particular regard to profit or the other motives that would concern a private industry. It is the author's opinion that this relationship of telecommunications vis-a-vis the national Government can give foreign Governments, Western Europe, the Soviet bloc, and the Third World an edge in preparations for the 1979 WARC.

Internal U.S. decisions by the FCC can and do have a major impact on worldwide telecommunications. Any FCC decision on an American common carrier can affect the carriers foreign partner. For example, the FCC denied the application of American Telephone and Telegraph Company (AT&T) and five other United States international common carriers to construct a new transatlantic submarine cable.[57,p.88] This not only had an impact on American firms but also 26 European and Canadian PTT's. Foreign Governments raise strenuous objections to a United States Government domestic agency imposing domestic regulatory policies on international telecommunications.

Similiar actions by the FCC have prompted the criticism that the FCC has become involved in making foreign communications policy. The FCC replies that, although it is not mandated to directly impose regulatory policies outside of the United States by the Communications Act of 1934, it must act in the "public interest." The FCC is playing a leading role in United States preparation for the 1979 WARC with this view of its function. The proposals they present, if adopted, will affect domestic and international telecommunications. The FCC does demonstrate an inability to recognize reality in international communications. This was evidenced by FCC Commissioner R. E. Lee's, statement concerning the 1977 ITU Broadcasting Satellites Conference as referenced in Chapter III section C. This attitude ignores the highly politicized nature of both the 1974 and 1977 ITU Conferences. To deal effectively at the 1979 WARC the United States must develop realistic positions taking into consideration politics as well as technical questions.

2. Third World

This topic has been covered earlier in this paper but the concern it is causing the United States in its preparations merits some further discussion. The LDC's see the technical domination of international telecommunications by the industrial nations (led by the United States) as part of a conscious effort to keep them in a subordinate and exploitable condition. The Third World has plainly revealed that this attitude is no longer acceptable to them. At the 1974 Maritime Conference and the 1977 Broadcasting Satellite conference they demanded and received allocations regardless of whether they could use them or not.[66,6]

The LDC's have established two priorities for the 1979 WARC. They are:[39,p.3]

1. Acquisition of additional broadcasting frequencies in high frequencies (HF).

2. Acquisition of as much of the non-broadcast frequencies as possible.

As discussed previously the frequencies could be used for barter or monetary exchange.

The challenge for the United States and the other industrial nations is the extent to which they can persuade the Third World to modify their demands in the interest of cooperation in solving international telecommunications problems. The industrial nations must be prepared to offer needed technical assistance to get the LDC's to focus their energies on legitimate problems instead of confrontation.

The role the Soviet Union and its satellites will play is uncertain and a matter of deep concern. The Soviets have a

great deal to lose if their spectrum allocations are significantly restricted. In the view of the authors, however, the Soviets support policies not in their direct interest to gain the confidence of the Third World. The Soviets trade off advantages in one area to reap benefits in more crucial areas to meet their long term policies.

It is the authors' opinion that the United States must respond both technically and politically. Our positions must be those that will generate support from the majority at the 1979 WARC. The United States must make every possible attempt to respond to legitimate Third World demands with offers of technical assistance and cooperation in order to avoid emotional arguments and "power" politics.

The decisions of the 1979 WARC will have a major impact on United States international telecommunications and information industries whether the U.S. Senate ratifies the document or not. The impact will be felt by the communications giants such as AT&T, United States government users such as Voice of America, the military services, NASA, and down to and including the AM broadcast on your car radio.[54,p.A-2]

The United States efforts should be coordinated at high Executive Branch level to insure that national security considerations are taken into account, balanced by economic and technical objectives. The IRAC/FCC, Ad Hoc 144 and U.S. CCIR study groups are now preparing for the 1979 WARC. Ideally, the authors' view is that the final delegation composition be broadly based, made up of industry, consumers, engineering and foreign policy specialists. Such a delegation may be able to deal better with the developing nations and improve our long term interests.

V. ALTERNATIVES

The primary areas where compromises are necessary are the High Frequency band, Satellite communications and general considerations.

A. SATELLITE SYSTEMS

This section is subdivided into two parts. First, technically sound alternatives are discussed. These alternatives, divorced of political ramifications, are in effect an attempt to use the periphery path of the model. This has been the historical U.S. approach. The second part discusses the political aspects of these alternatives. In terms of the model, these political questions have entered the decision box without addressing technology. It is at this junction that the technical alternatives are modified and reshaped by the additional political factors. The outputs are the compromise decisions.

1. Technical Feasibility

In the area of Satellite communications the possible proposals in the authors' view are:

a. Create exclusive bands for Fixed Satellites and Broadcast Satellites.

b. Continued sharing of Fixed and Broadcast Satellite bands but increased allocations.

c. No increase in allocations and bands remain shared.

d. Creation of exclusive bands for Fixed or Broadcast Satellites but not both.

e. Variations of the above 4 possibilities.

Fixed Satellite service operates point to point, utilizes high power uplinks with large and small area coverages. Intelsat V will operate in the 11 and 14 GHz bands as will the European Communication Satellite (ECS), while Satellite Business Systems (SBS) will operate in the 12 and 14 GHz band. [11,p.36] DOD's new systems are in the 7 and 8 GHz bands. Other systems are planned in many areas of this portion of spectrum. The Fixed Satellite Service have been accommodated in their present bands for many years supporting such vital services such as military communications and telephone circuits. It is the opinion of the authors that since changes in these allocations would not only be costly in terms of dollars but also in degradation of these vital services, the present allocations must be protected.

Satellite broadcast systems have widespread applications in and out of government. They are, however, mostly profit oriented systems. Additionally broadcast systems, while technically feasible now, will require a significant transition period prior to becoming fully operational. The Broadcast Satellite systems can also be accommodated at higher frequencies due to their limited coverage and higher attenuation factors.

No matter which option is selected, it is the authors' opinion that there will be an increase in associated costs. It is therefore better to have this increased cost used for development of sharing techniques throughout the spectrum rather than for wholesale band changes and subsequent losses in efficiency. Those systems operational and presently planned (development stages) should be protected. Future systems should be fit into

the higher bands or around existing systems on a not to interfere basis. A number of government and industry papers reviewed for this study indicated that while not feasible in all areas of the spectrum, sharing between Fixed and Broadcast Satellites is feasible above 40 GHz.[53,p.30] With coordination on orbit spacing this sharing could be extended below 40 GHz. This supports the already existant need for coordination among the Fixed systems heavily concentrated below 20 GHz.

With the recent technological advances opening higher frequencies the Broadcast Satellite interest should be encouraged to design systems above 40 GHz. Usually in order to be effective Broadcast Satellites require small area footprints such as the Japanese Islands, or the UK. At lower frequencies this requires high gain receive antennas which are large and uneconomical, or high power from the satellite which is also uneconomical.[32,p.40] The approximate relationship of gain and beamwidth is[32,p.2-3]

$$\Theta = \sqrt{\frac{27000}{G}}$$

Additionally gain is inversely proportional to wavelength squared; therefore, at higher frequencies a given antenna will have significantly increased gain and therefore a smaller beamwidth. (double the frequency increases gain by a factor of four and reduces beamwidth by $\frac{1}{2}$). The problem of increased power required to overcome free space losses and effects such as rain can be solved[46,p.15-6] The newest NASA transmitters provide 200 watts of output power and mark a significant jump in available satellite power. The power increases are being

obtained reasonably increased costs, which if historical trends hold true should decrease. Another significant economy that should be mentioned is the use of the space shuttle; [14,p.57] placing larger payloads (associated with higher frequency satellites) into earth orbit will be less expensive, and the higher frequencies are better suited to Broadcast satellite techniques. [14,p.58] For these reasons encouragement should be given to placing new Broadcast systems at higher frequencies.

One possible method of coordination is a "scaling law" system based on single and multiple protection ratios with budgeted or targeted separation angles. This criteria would likely be complex because of the variety of satellite systems using geostationary orbits. (International standardization of hardware would be costly). A better method might be a segmentation technique. The two dominant factors affecting satellite spacing are earth station gain (on axis of sattellite) and RF signal structure resulting from different modulation methods used. [53] The unhomogeneity resulting from differences in on-axis gain results from the use of differently sized antennas at the earth stations and is, in essence, caused by higher sidelobe radiation from smaller antennas. The differences from modulation techniques has occurred because of the mixture of modulation methods with low ratio (5-8db) of peak power density (PPD) to average power density (FDM/FM and some digital) with those that have a higher (15DB) peak to average power density (TV and single channel per carrier FM).

A frequency segmentation plan could be developed to reduce the differences. Under this concept, systems with low-gain

antennas and large ratios of peak to average power densities would use one portion of a band while systems with high gain and low peak to average power ratios would use another, thereby reducing the required orbit spacing between satellites.[53,p.27] This segmentation requires the utilization of power density limits. The concept is applicable to all bands, but the power density limits would be unique to each band.

It is beyond the scope of this study to further develop these limits other than to state that the concept is technically viable. Additional research should be accomplished to divide the bands and determine the cut off frequencies. Once the division is identified, systems can be given an efficiency rating to determine the amount of the band allocated. A possible approach is to utilize the efficiency concepts put forth by Leslie A. Berry of NTIA in his article MEASURING SPECTRUM USE in WIRELESS WORLD, December 1978. (Ref.23) His concept utilized the equation:

$$\text{EFFICIENCY} = \frac{\text{COMMUNICATIONS ACHIEVED}}{\text{SPECTRUM SPACE USED}}$$

This measure, while complicated, will provide a ranking method for systems within each service to assist planners in blocking the systems within the proper bands.

In summary, Fixed and Broadcast Satellite allocations can be shared. With close coordination, new systems can still be placed in lower portions of the band utilizing an orbit segmentation plan. Broadcast Satellite interests should be encouraged to develop systems at higher frequencies.

2. Political

The above recommendations are technically feasible, but can they or at least a similar proposal be adopted? The decision box is no longer transparent. As stated earlier, the LDCś have a suspicion of Broadcast services because most of these countries see them as a possible destabalyzing factor. This is why they seek control of Broadcasting within their boundaries. On the other hand they view FIXED Satellite services as something to which they should have access. It is the authors opinion that only the more advanced of the LDC's have a valid need for Satellite service, but most seek it if only as a source of national pride. As noted before they also are on record as wanting frequencies for each service allocated by nation rather than the present method of first come first serve. [61]

The authors' perception is that the political position of the LDC's then will probably be to expand FIXED allocations, limit Broadcast services and allocate the frequencies by nation.

It is in the U.S. interest to expand both Fixed and Broadcast services. To achieve this, the LDC's must be convinced that supporting increased Broadcast Bands will not be harmful to them, not an easy task as discussed previously, the developed countries (US particularly) and the LDC's have been at odds on control of broadcast content for some time. There are several possible options. One might be to allow national or at least regional control of Broadcasting. This solution would probably eliminate any chance for Congressional ratification of WARC 79 protocols and therefore is infeasible. Second, the U.S. could fight for free access and take a reservation if controls are

voted. This solution would allow the U.S. to follow an independent course but would still be damaging to ratification by the Senate. Third, the U.S. could offer assistance to certain groups of LDC's in developing their own regional broadcast organizations. This assistance could be a means of obtaining these nations' support for our non-control position and drive a wedge in the solidarity of the LDC bloc. The third solution, we feel is the best based upon experience at recent conferences. The LDC's, or at least a meaningful percentage of them, were convinced not to push for controls at the 1977 WARC. Their continued support could be gained if they were offered a meaningful alternative to national control. That alternative is the ability to make their views known in news, informational, educational and entertainment broadcasts. This must be negotiated prior to the convening of WARC. In the opinion of the authors, the best prospects are the Indonesian, Phillipine, Maylasia, Thailand group, South American countries and the Middle Eastern countries of Saudi Arabia, Iran, Egypt, Sudan, Jordan and Lebanon. If these countries could be convinced they might draw a few more LDC's to the U.S. view and the national control issue could be diffused.

Assuming the successful resolution of the control issue, the problem of Broadcast allocations would be simpler. The technical arguments should prevail once the political issues are separated. The last and possibly most difficult issue will be the allocation of these frequencies by nation.

Areas 1 and 3 have already allocated Satellite Broadcast Frequencies by nation, and the Maritime frequencies are

similarly allocated although the U.S. took a reservation on this issue. It appears that given events of the recent past, national allocations are inevitable. Support for this issue is very strong within the LDC bloc.[61] The best strategy for the U.S. will be to strike some compromise position. The technical arguments support orbit segmentation which is really frequency segmentation to avoid interference. One possible solution in the authors' opinion is a full allocation plan by nation which will be inefficient and difficult to enforce. The solution at the other extreme is again to fight for the status quo and take a reservation. This would probably be a singular exercise since even the usual U.S. supporters in region 2 support national allocations. The best solution is in a compromise that allows as much free access as possible and also reserves some frequencies for national use. A U.S. position that allows at least token national allocations will avoid costly confrontations that can undermine other proposals. The proposal should allow for some frequencies to be allocated on a technical user basis and reserve some for each nation now capable of utilizing them. In the opinion of the authors a third set of frequencies should be kept in a reserved pool for other nations (LDC's) to draw upon when needed. The actual frequencies to be allocated to each nation should be decided at specialized regional WARC's thus delaying the action up to 5 years. This will provide a buffer for new design systems during any transition period negotiated at a specialized WARC. This could force some inefficiencies and even increase costs due to technical factors. The LDC's could also choose to lease their frequencies to others

at ITU set rates. This would be another added cost, but better than an OPEC fashioned frequency cartel that could set arbitrary rates. The extremes could be so disastrous that the compromise must be pushed by the U.S.

In the view of the authors, the above discussions are a demonstration of how the allocation model could function. Pragmatically it does not provide the optimum technical or political solution separately. It can provide the optimal combination if the decision forming factors are studied and utilized. The result of the above process is an allocation consisting of some expansion and some modification. Both, as noted in the discussion, provide some benefits. Since the allocation will be a compromise decision, it must be assumed it will also have some opportunity costs that must be forgone. The end effect is to move the model toward equilibrium in the short term. The long term effect is not an absolute in the view of the authors. Historical precedent should dictate a further increase in demand over time due to the expanded usable spectrum technology opens to new users. This could, however, be counterbalanced by the increased costs of further modification or expansion. In other words each time the model nears equilibrium it becomes more difficult to start the process again. This opinion is drawn from the increased cost of utilizing higher frequency segments even in the face of growing demand rates.

The U.S. can accomplish these goals through the full use of its political, technical and economic strength.

B. THE HIGH FREQUENCY BANDS

The High Frequency (HF) portion of the spectrum has been the most popular band since its use began in the 1920's.[63,p.11] The present HF spectrum is, in the authors' view, a product of the Allocation Model. It has evolved first by the technological path and more recently, almost exclusively through the political path. The need (demand) for expanded communications forced spectrum use above 3 MHz during and after World War I. The ability (technical and fiscal) to build such needed receivers and transmitters was not a problem. Shortly after the conclusion of World War II the HF spectrum range of 3 to 30 MHz was fully allocated. The birth of new nations in Africa and Asia highlighted the increased demand for HF allocation while at the same time there was limited technical expansion cabability available. During the transition period of 1959 to 1971 the new Third World nations organized themselves into a policy bloc by using their power in the regulatory process to achieve their goals. Thus their voting power in the ITU and potentially at the 1979 WARC gives them the capability to attain through the regulation process what they cannot afford in technological advances. These concepts of HF usage are expanded and the US. Navy's position examined in this section.

1. Technical/Political

Since World War I, when 3 MHz was used for naval communications, HF has become the "workhorse" in international and maritime communications. Advancing technology created and encouraged the desire for additional uses faster than it produced the means to cope with the problem of demand exceeding

supply. Anytime there is a highly desirable, limited natural resource the competition for that resource is very intense. The overcrowding of the HF radio spectrum becomes readily apparent when one considers that the method used to contain the use of HF within spectrum allocation is a voluntary adherence program on the part of all nations to a rigid frequency and time sharing schedule. Nearly 100 countries, employing over 1365 transmitters, a large percentage being between 100 and 250 kilowatt (KW), are engaged in HF international broadcasting and more countries are demanding allocations for that purpose.[54,p.4-3]

The intolerable levels of interference and congestion in existing HF broadcasting bands have been meticulously documented and substantiated in that less than 35 percent of all frequencies used are interference free.[5,p.2] Of the frequencies used by the United States for broadcasting, approximately 50 percent are seriously degraded by interference. Not included in this figure are those frequencies jammed by the Soviet Union and others.[5,p.2] To further complicate the interference problem, the Soviet Union has scheduled the use of huge 500 KW transmitters for broadcasting purposes.

The impact of the rapid worldwide growth in uses of HF has been felt in the following areas:

-- in the increased amount of coordination and engineering required to accommodate a new or expanded use, thus greater cost;

-- in greater depth of engineering studies to determine the electromagnetic compatability with environment and side effects of the proposed operation, thus greater cost;

-- in the need for increased application of improved technology such as:

. smaller channel separations and equipment capable of operating within such channels;

. highly directive antennas;

. improved methods of modulation requiring less spectrum bandwidth and more resistant to undesired signals;

. broadband high-capacity techniques vs many narrowband channels where spectrum will be saved;

. real-time information on high frequency propagation conditions obtained by methods such as oblique ionospheric sounders, to ensure use of the best frequency at all times and get greater results from the few frequencies available.

-- in the need for much more specific information on existing operations and terrain features;

-- in longer time to get an authorization;

-- in longer waiting time to get a free channel when frequencies are shared with other users; and

-- in the need to accomodate some expansion of existing and new operations, as well as to reaccommodate some existing operations, higher in the spectrum.[54,p.E-2]

The authors' opinion is that these purely technical problems will require much more than the proposed technical solutions. The representatives of the nations of the world must give due consideration to political-economic factors or they will not come close to solving the problems of frequency allocations.

With the enormous level of overcrowding and resulting interference in the HF radio spectrum bands, the question is asked, why not shift some requirements to other portions of the spectrum? The acid test of any telecommunications system is; will it work in the intended environment at the desired level of efficiency, without suffering degradation to performance or adding to that of other systems operating in that same environment? The radio spectrum itself is the culprit in the problem simply because of its nature.

As noted previously, the radio spectrum has natural constraints. It is not limitless. The radio spectrum is not elastic. A channel cannot be occupied in the same geographic space by two or more users without degrading interference resulting. Many tasks can only be performed in certain portions of the spectrum. Substitution of one frequency band for another cannot work in parts of the spectrum because of propagation characteristics, atmospheric conditions, and bandwidth limitations. The radio spectrum does not follow geographical boundaries; consequently, your vital information is another's radio interference. The simple truth is that many dedicated high frequency functions just cannot be performed in any other frequency band.

The users of the HF radio spectrum have existed so long with the congestion problem that they view it as a fact of life. In response to this, users are being forced to take expensive measures and counter-measures to squeeze the best use out of the frequencies available.

Prsident Truman, in February 1950, created the President's Communication Policy Board. In creating this board he stated that the shortage of high frequencies was, "the most pressing communication problem at this particular time," and one that, "is rapidly assuming major prominence."[54,p.F-11] The HF radio has not lost any importance to the United States with the passing of time. President Carter expressed his views on the importance of HF in supporting foreign policy through the United States International Broadcast by stating, "This Administration firmly supports United States International Broadcasting as a part of our committment to the free flow of information and ideas. International Broadcasting is a key element of the United States foreign policy. Communicating our policies, ideals, and traditions of free information to the peoples of the world is of vital importance to the security of the United States and the structure of peace."[58,p.2]

There are two dominant themes in the Federal Government use of the radio spectrum:

1. The requirement for telecommunications is placed upon the Federal Agencies by virtue of the missions and programs approved by the President consistent with Congressional legislative funding support, and

2. The use of radio rather than any other form of communications is dictated by the inescapable elements of time and space.[1,p.5]

The depth of the United States Government involvement is represented by the following:[1,p.8]

1. The total United States Government investment in communication-electronics equipment is in the billions of dollars (approximately $67 Billion in 1977);

2. The number of United States Government equipments operating throughout the radio spectrum is in the millions;

3. The number of United States Government radio frequency assignments is over 140,000. One assignment may represent hundreds or even thousands of individual stations or equipments;

4. The variety of the Federal Agency missions that depend on radio is innumerable.

The relationship between the basic mission of a given Agency, the facilities needed to fulfill that mission, and the requirements for corresponding radio frequency spectrum space must be recognized, for these three items are inseparable if the mission is to be effectively accomplished. For example, military operations would be at Civil War effectiveness levels without communications-electronics equipment for all phases of support of their mission, to protect United States interests throughout the world.

The paramount requirement of military communications-electronics is to provide telecommunications, navigation, and special purpose electronic systems that are responsive to the requirements of the National Command Authority, the Joint Chiefs of Staff, Commanders of the Unified and Specified Commands, the military services, and defense agencies in the accomplishment of designated missions and functions in peacetime, contingency situations at all levels of conflict, including general nuclear warfare. Military telecommunications systems accommodate

crisis management, facilitating a rapid transtion from peace to war. The success of military operations is undeniably tied to the ability to use the radio spectrum as needed.

The HF spectrum is critical to the plans of the Department of Defense to carry out its command, control and communications (C^3) functions of the tactical and strategic forces at its disposal. The military's needs are to be satisfied while minimizing the impact on other users through efficiently exercised management. [17,p.3] These needs are met so that the primary uses of the radio spectrum are in accordance with the International Radio Regulations. The secondary needs of the services are met on a not to interfere basis.

A sound management program of resources is needed to support a balanced and operationally effective training/contingency program for the military force structure. It is only through diligent and progressive management and technological advancement that the radio frequency spectrum requirements, incident to national readiness and security, can be met. Given the foregoing, decisions made at the 1979 WARC concerning the HF radio spectrum will determine how this spectrum region will be used and applied through the year 2000. With the military security of the United States at stake, the United States must develop sound positions concerning those frequencies that are essential, and to protect them by accommodating the legitimate needs of other users where feasible.

2. The Navy and HF Uses

The Navy has requirements in the HF frequency band that are in many instances unique and thus are often misunderstood

by other users for that reason. It is the authors' view, that given the advances in satellite communications, HF communications are still presently the only practicable means to communicate with deployed aircraft and ships at sea. The variation in needs to communicate with aircraft and ships complicates the coordination processes in obtaining or retaining frequencies for such requirements. In the past the Navy has gained little or no sympathy from other users, nor should it expect it in the future, for its unique problems. Cooperation could be improved if the Navy took the initiative and the opportunity in the proper forum to indicate to others what the unique problems that the Navy faces in the HF bands are. This would allow other users, even if they didn't agree with the Navy position, to at least understand it.

Some specific examples of unique Navy requirements will be discissed in the following paragraphs:

a) To prosecute an Anti-Submarine Warfare (ASW) problem, it is crucial that effective communications be maintained. Satisfying ASW needs in the HF band requires a frequency on which ships, aircraft, coast stations, ground stations, and sometimes land mobile and fixed stations can all communicate with each other in a complex net. Such a net often requires one or more types of emissions. The problem focuses on the fact that in the 4MHz to 25MHz region there is really no precise allocation in the international table of frequency allocations that satisfies completely these requirements. The Navy is thus forced to improvise taking due note to select discrete assignments in the HF band to minimize the impact on other users of the

spectrum while meeting its committments. Such decisions could place the ASW operation in the exclusive fixed bands making the fixed portions "in band" but the mobile portions "out of band." Similiarly, a frequency used in the exclusive maritime mobile band would place the shore and ship portions "in band" but the aircraft, land mobile and fixed portions "out of band." An exclusive aeronautical mobile band would satisfy the ground and air portions while the ship and fixed portions would be "out of band." Those portions of the net operating out of band usually are not derrogatory to the international allocation table. This type of operation is permitted under various special Radio Regulations which provide for exceptional use of frequencies in otherwise exclusive bands.

b) A Navy broadcast requires a coast station to transmit simultaneously to a number of deployed ships and sometimes to another fixed receiver. The dedicated band from a table allocation standpoint is the exclusive coast telegraph bands. Congestion sometimes prevents these requirements from being met in the movement of the broadcast to the exclusive fixed bands. Again this can be done under the exceptional provisions of the Radio Regulations.

c) Due to the unavailability of suitable exclusive coast and ship telegraphy bands some primary ship/shore requirements must be met in the fixed bands.

d) Due to the unavailability of suitable exclusive aeronautical mobile bands, some primary air/ground requirements must be met in the fixed bands.

e) Navy ships carry an HF communication suit far more extensive than that carried by non-Navy vessels. The suit more resembles that of a large communications land station. A Navy ship maintains continuous communications simultaneously on a variety of circuits of various emission types. A Navy ship can and sometimes must terminate with many different shore stations of various types, distances, azimuths from the ship, and communication suits. A significant problem with Naval communications is how to configure the antennas on ships and planes. Ships and planes do not have the luxury of choosing large antenna farms of optimum location and height as do shore stations. A ship's transmit and receive antennas and equipment must of necessity be crammed together on a small platform in an environment where communications are a support element to the ship's main function. This fact multiplies equipment compatibility problems between various HF apparatus. Naval HF communications must also endure problems created by its use of frequencies above and below the HF band. Naval communications usually have a far greater impact on other users than those users have on the Navy. This further complicates the problem of obtaining suitable frequencies for Navy ships.[17,p.2]

The Navy is expected to retain its HF broadcast capability and use it for at least the next twenty years. The Naval Telecommunications System will need high message transmission reliability with the lowest possible message transmission redundancy. To improve its frequency utilization, the Navy is planning to employ oblique ionospheric and channel sounding systems. These "sounders" will:

a) Improve operations employing HF and offer high probability of selecting frequencies to support communications.

b) Provide the choice of optimum frequency in real time and simultaneously reduce the number of on-line equipments.

c) Provide more efficient use of the radio spectrum and lessen congestion if real time information is available to HF communication systems.[27,p.13]

The problem of proper frequency selection is very difficult to program in advance due to the dynamic nature of the propagation medium. The "sounder" systems should help considerably.

Another technical development that has the potential for easing the HF congestion problem is a conversion to single side band (SSB) systems. By using SSB technology the applicable bands within the HF spectrum could be effectively doubled. The conversion to SSB is a very attractive possibility, but it has drawbacks. A SSB communications system would require both transmitter and receiver to be SSB capable. The conversion from conventional equipment to SSB equipment would entail significant economic costs and transition problems. Such a measure would, therefore, encounter strong opposition both internationally and domestically. One only has to multiply the millions of individual transmitters and receivers currently in operation by the dollar cost of SSB conversion or replacement to see that the cost would run into the hundreds of millions of dollars.

The high cost of new technology is one of the reasons the lesser developed countries are demanding that the developed countries vacate the conventional communications bands. One would not expect that the LDC's would accept such a plan as SSB

conversion without some form of conversion cost and technological subsidization. The total political-economic benefits must be weighed in the implementation of such a plan. The long term gains in international telecommunications cooperation may merit the short term costs to the United States and other developed nations.

In summary, the HF region of the radio spectrum is vital to the domestic and international communications of the private and public interests of the United States. There are limited gains that can be made through technology. The authors feel that the level of information that users want to transmit makes bandwidth reductions, beyond those gained by using SSB techniques, impractical. The HF portion of the spectrum does not have room for expansion, therefore in terms of the authors' model the cost of the technological path approaches infinity leaving the political path and re-allocation of HF resources as the only acceptable alternative to those desiring HF services. The United States cannot afford to be in an inferior political negotiating position on HF issues. To continue to deliver its views of news and politics to the rest of the world, the United States must have dedicated International Broadcast frequencies. In the age of potential nuclear war the HF radio spectrum plays a crucial role in the effective command and control of strategic and tactical forces. The Navy must have a reliable, real time exchange of information available to commanders through all contingencies including a loss of all satellite communications, and general nuclear war. The Navy must maintain and continue to develop HF point-to-point communications until satellites are

war survivable either through technical improvement or redundancy. These requirements can only be met by access to the needed radio frequencies. To protect their interests the United States and the Navy must develop positions which not only meet their parochial interests but which also look realistically at the world as a whole in economic, political, and technical terms.

C. POSSIBLE MODIFICATIONS FOR FUTURE OUTCOMES

The role of world leadership came to the United States rapidly and to some extent without conscious action by its leaders. The United States reluctantly entered World War I. Due to political policies by President Wilson and the isolationist attitude of the country, the United States stayed out of the League of Nations, probably dooming that organization to failure. The isolationist spirit captivated the country through the depression and up until December 7, 1941 when the United States entered World War II.

President Roosevelt, early in the War developed the support for the United Nations. The end of World War II saw the United States as the only major world power that had not been ravaged by the war. The only two nations with significant military strength were the United States and the Soviet Union. Thus in the space of four years the United States found itself as the leader of the Western world, the strongest military power on earth, and in the beginnings of the Cold War.[7,p.15]

This rapid change in the American character did not allow time for international experience to accompany its international power. The recovery of Japan, Germany, and Western Europe

depended on the aid of the United States. This led to a high spirit of cooperation among the former Allies and enemies. The policies and desires of the United States, being tied to recovery, were for the most part approved by the U.S. Congress and the recipient foreign nations.

The second World War and the desire by native peoples for independence from their former colonial rulers also accelerated a realignment in world politics. The world of the second half of the twentieth century no longer consisted of four or five major powers but of hundreds of nations demanding equal access to political power and economic wealth.

If one member of the world community has a preponderance of power, economic and military, that nation can force the model to function on the peripheral path. In that case the decision box is transparent since the leading nation has already arrived at a decision and no other member is strong enough to challenge it. This is the historical U.S. position. In the opinion of the authors that position is no longer valid. The U.S.'s proposals are challenged today by nations with economic power approaching that of our own such as the USSR, West Germany and Japan. Additionally they are challenged by the not so powerful by banning together into blocs such as the Third World, group of 77. In terms of the model these challenges are viewed in two ways, both having the same effect. In the first case challenges by near equals are based upon technological as well as political grounds and therefore tend to dilute the credibility of the U.S. proposals as they enter the decision box. This dilution will occur any time two or more proposals enter that are

technologically opposed in any degree. The second case of the less powerful and lesser developed nations in effect short circuits the peripheral process by bypassing the technology for purely political solutions. As noted previously the effect is the same. A blockage occurs at the decision box due to opposing proposals.

How can this blockage be removed. There are two possibilities. One is withdrawal from the Union, the second is to change the structure of the decision box by altering our strategy toward the ITU.

The withdrawal precedent was established by the United States withdrawal from the International Labor Organization. The extreme politization of that body was its downfall.[7,p.2] Many fear the same course is being followed by the I.T.U. The benefits of staying versus the costs of remaining a member must be examined.

The new majority in the I.T.U. is both vocal and insistent. Their political existence has brought a new contemporary multilateral diplomacy that painstakingly slows the diplomatic process. Their voting power has forced an interdependence of all parties. The feeling is that all members need each other and therefore decision making must be a collective or consensus process.

The frustration and problems the United States faces at the 1979 General World Administrative Radio Conference (GWARC) were not present at the 1959 GWARC. Delegates from the 1959 GWARC reported optimistically that it, "provided the opportunity to advance with representatives of other countries the position

and point of view of the United States on international telecommunications questions generally and to encourage full understanding and friendly cooperation between the participating countries. It is believed that the collaboration between the United States and other countries maintained the best traditions of the I.T.U. in its long record of international cooperation and accomplishment."[6,p.11] The same report on the 1959 conference stated that a "more experienced delegation from the developing countries would move in the direction of accomplishment of the United States' objectives."[6,p.14]

What are the benefits of the I.T.U. that would merit such a positive opinion? The I.T.U. performs the functions of allocating frequencies for specific purposes, establishing communications procedures to insure safety of life, providing a registration of frequencies by user and use, and bringing together the world's telecommunications experts to solve problems and share expertise. In addition to these technical services, the I.T.U. provides another forum in which the United States can utilize its superior technology and refine its international diplomacy.

The costs of I.T.U. membership are more than just financial. The issues are more emotional than they are technical. The results of the 1973 Torremolinos Conference prompted the United States' delegate to report that too much time was spent on matters that had nothing to do with the traditional I.T.U. role. This caused serious doubt about the, "continuing usefulness of the I.T.U. as an international regulatory agency for telecommunications."[6,p.17] The problems experienced with

pre-allocation of maritime frequencies at the Maritime WARC brought the suggestion that the United States ought to, "look for an alternative forum to resolve the kind of issues that the I.T.U. was once attuned to handle."[7,p.2]

The new majority in the I.T.U. has shifted the emphasis from regulating frequencies to, "the obtaining of more funds from the major contributors to the I.T.U. ... than furtherance of the basic purposes of the Union."[6,p.17] This placed further doubt on the I.T.U.'s ability to effectively function as a regulatory agency. Many consider the United States threats of withdrawal more, "frustration than a serious desire to withdraw from the I.T.U.."[6,p.18] However, withdrawal by the United States and other industrial nations is a real possibility that the developing countries must seriously consider.

Some political observers feel that withdrawal should not be an alternative open to the United States. Former United Nations Ambassador Patrick Moynihan stated, "We are witnessing the emergence of a world order dominated arithmetically by the countries of the Third World. This order is already too much developed for the United States or any other nation to think of opting out. It can't be done. One may become a delinquent in this nascent world society. An outcast in it. But one remains 'in' it."[7,p,13] Another former United Nations Ambassador, Mr. John Scali said, "...we can seek to lead--not as the sole headquarters of justice and wisdom, but as one who recognizes that new and exciting doors can be opened by many countries in an increasingly interdependent world."[7,p.14] There must be however, a bottom line to the United States spirit of cooperation.

Former Secretary of State Henry Kissinger stated that in international organizations and agreements, "there are limits beyond which the U.S. will not go."[45,p.11] The I.T.U. isn't the only international organizational problem the United States is now facing. At the Law of the Sea Conference the Third World organized into the Group of 77. This group demanded that any benefits of private mining of the oceans floor be passed on to all nations. Under this pressure to act, the Congress passed its own law licensing sea floor mining. Additionally, Multinational corporations involved have pressured their home governments to sign mini-treaties.

What then should the U.S. do? The authors' feel that the U.S. should remain within the I.T.U. as a member. There are, of course, variations to this alternative. The U.S. could seek support for its views when success is viewed possible and remain dormant and non-committal when the outcome does not appear to be successful. Of course this is really where the U.S. is today. Without any real power or "national will" to defend our interests, the U.S. tends to play the odds by presenting its proposals, withdrawing anything offensive, and finally considering itself successful to sustain minor losses or the "status quo". As described earlier in Chapter III the LDC's are becoming a strong political force. If the framework remains the same along with our strategy then it is only a matter of time before the U.S. will begin to feel a frequency pinch.

The role of International organizations in International relations is to create an atmosphere which tends to view nations and their political leaders as being capable of learning new

behavior patterns and eventually, on an evolutionary basis, of surrendering at least part of their sovereignty to international cooperative efforts in order to rationalize their relationships among one another.[34,p.9] Unlike international law, which is more heavily based on natural law morality and traditional concepts of state, theories of international organization, while heavily indebted to these earlier concepts, have tended to rely more on premises based on psychological and sociological motivations and functions. Do the international organizations of the present meet these definitions? Partially. The cooperative atmosphere is created by bringing nations together in a hall rather than on a battle field, and some organizations in the past have demonstrated the evolutionary process noted above.[34,p.9] The problem is, however, that all members of an organization are not at equal positions in this evolutionary process, therefore each member brings different goals and negotiating abilities to the organization. Countries that have belonged to these organizations for many years usually are willing to compromise some of their own interests in order to attain a greater common good among other long time members. The lesser developed countries, in the authors' opinion, being more recent on the scene have not reached this evolutionary stage and therefore utilize the forum for their own interests rather than a common good. Of course "common good", just as beauty, is in the eye of the beholder. The point is that the older developed nations, confident of their position, are more willing to cooperate in mutual efforts than are the Third World nations.

International organizations are of two types. The "welfare" type and the "quasi-commercial" type. The difference is that "welfare" systems operate primarily through political decisions while the "commercial" type puts prime importance on the financial implications.[34,p.158] The I.T.U. is in the former category and INTELSAT is an example of the latter. The evolutionary process cited above will carry an organization from the former to the latter by first equalizing the welfare goals of members, thus allowing future deliberations to be on a cost/benefit basis. Of course some organizations by-pass the first stage by having members with already agreed upon welfare goals. The I.T.U. is not one of these.

It is therefore necessary to equalize the welfare goals of I.T.U. members through some organizational structure before that organization can operate effectively. The U.N. is a prime example of an organization that has been unable to do this, primarily because its members are so diverse in their needs and desires. The I.T.U. also suffers from this symptom.

If the needs and desires of a region are studied, however, the individual national desires become blurred and the welfare goals of geographic regions of the world tend to edge toward equalization. In other words the needs of say Asia are not that much different than those of a North/Central American region. Both contain needs of developed and lesser developed nations that can be somewhat submerged under the regions overall welfare goals.

The proposed structural changes in the I.T.U. therefore are that regional sub-I.T.U.'s be formed to equalize their goals.

The conflicts that are presently utilizing so much energy in a world wide body could be internalized to regions prior to arriving at a global consensus. On a regional basis political hostilities would be reduced due to interdependencies. Once this regionalization of welfare goals is accomplished the evolutionary step to a cost/benefit "quasi-commercial" organization is attainable through pooling of resources and regional economic assistance. Compromises are easier due to the ability of developed nations within a region to assist the LDC's in attaining a more efficient use of spectrum and improved national welfare.

Some so called natural regional groupings exist now, such as Africa and the Middle East, on a racial or cultural basis. The great difficulty in accomplishing a workable regional plan is that it will probably have to be done through a WARC. It is therefore possible that the very thing the regional plan solves will be the primary stumbling block to implementation.

Because of this possibility it is imperative that bilateral and some multilateral negotiations be carried on with selected countries throughout the world. Which countries the U.S. chooses to negotiate with will be decided by their stature within their regions. At the writing of this paper the list would include China, Japan and India in Asia; Eygpt and Saudi Arabia in the Middle East, Nigeria, Tanzania and Kenya in Africa, Great Britain, West Germany and France in Europe; Brazil, Venezuela and Argentina in South America and; Canada and Mexico in North/Central America. This list is not all inclusive and is only cited as an example of the size of the task. The U.S. presently conducts bilateral discussions prior to a WARC as a

normal part of its preparations. These discussions should provide a starting point for negotiating informal agreements concerning regionalization concepts. But we must be prepared to try and accommodate other countries requirements. Unless we are prepared to do this, such negotiations would give the appearance of a sham and could do more harm than good.[61] To be successful these negotiations must also not be limited to telecommunications matters only but should cover other associated economic issues such as systems development and equipment sales. The U.S. has much to offer in return for cooperation. We should use it.

Assuming the above regional plan is attainable, it is the authors' position that the next step is the creation of a frequency market where the regions interplay their needs. The final character of this "quasi-commercial" I.T.U. is beyond the scope of this paper and therefore only a few possibilities are listed here.[26,p.86]

1. FREELY TRANSFERRABLE RIGHTS

   Rights created by the International body, whether through inclusion or exclusion, are freely transferrable, with spectrum bought and sold outright. Secondary transfers of rights allowed (country to country and region to region)

2. AUCTIONS

   Set user charges by service and frequency.

3. CHARGES TO USERS

   Charges applied on spectrum occupied by a user, as measured by some index of physical use.

4. SHADOW PRICES

Prices derived from maximum sums that current spectrum users would be willing to pay; rather than do without some amount of spectrum.

The above alternatives are only briefly mentioned to provide a starting point for further research in this area to find an optimal method in terms of economic and political benefits.

The above paragraphs provide a method for amending the ITU's structure so that it will become more functional and less political. This metamorphis is in itself a political process. As noted earlier the second avenue open to the U.S. in remaining within the union is a change in strategy toward the organization.

In the opinion of the authors, the United States must develop a new method of political action. As it cannot be the world's policeman neither can it be the world's checkbook. It is the viewpoint of the authors that the United States should tie its technologically strong positions, such as telecommunications, and its capital financing strengths to the trade of resources held by other nations. In effect use the "Common Heritage of Man" philosophy for our benefit. The U.S. should not separate the areas where it is strong from the areas where it is weak. The U.S. must recognize its strengths as a major source of technology and capital, and use these assets of power. The U.S. should seek out those nations with legitimate communication needs and arrange an exchange of technological and monetary assistance for trade agreements concerning other natural resources.

The U.S. should not withdraw from the I.T.U. but should fight politics with politics. A new strategy must be developed. Such a strategy will not be effective, however, if the U.S. continues its past pattern of last minute uncoordinated preparations for I.T.U. and other international conferences. There must be a high level, precise policy to follow.

The U.S. should be prepared to meet some of the legitimate needs of the Third World, but not alone. All the developed countries must pay part of the price of the new politics. The ITU as a whole must pay the price of learning how to work together. No nation's policies in the ITU will be accepted because of power, extent of telecommunications systems, or even logic. It may not sound popular but the term "power politics" is still valid and must be the corner stone of any new strategy in our ITU relationship.

APPENDIX A

INTERNATIONAL FREQUENCY MANAGEMENT

The radio frequency spectrum is controlled both internationally and domestically. Management of the spectrum on the domestic front is accomplished primarily through the FCC, Commerce and Defense Departments. The workings and relationships of this domestic management are complex they are however, only tangentially relevant to this paper and therefore will be treated only in relation to their effect on the International Radio Spectrum management issue. On the international side, the primary player is the International Telecommunications Union (ITU). Born at Madrid in 1932, the Union has grown from 78 to 154 member nations and has become a recognized organ of the United Nations. As the world's supreme forum for telecommunications matters, the Union reviews and passes judgement on frequency spectrum allocations.

The ITU's mission, according to its charter is to:

1. Maintain and extend international cooperation for telecommunications of all kinds.
2. Promote the development of technical facilities with a view toward improving the efficiency of telecommunications services, and insofar as possible, making them available to the public, and
3. Harmonize the actions of nations in the attainment of these common ends. [54, p.C-15]

In particular, the Union (a) effects the allocation of the radio frequency spectrum and registration of radio frequency assignments in order to avoid harmful interference between radio stations of different countries; (b) coordinates efforts to eliminate harmful interference between radio stations of different countries and improve the use made of the radio spectrum; (c) fosters collaboration among its members with a view to the establishment of rates at levels as low as possible consistent with an efficient service and taking into account the necessity for maintaining independent financial administration of telecommunications on a sound basis; (d) fosters the creation, development and improvement of telecommunications equipment and networks in new or developing countries by every means at its disposal, especially in participation in the appropriate programs of the United Nations; (e) promotes the adoption of measures for ensuring the safety of life through the cooperation of telecommunications services; and (f) undertakes studies, makes regulations, adopts resolutions, formulates recommendations and opinions, and collects and publishes information concerning telecommunications matters for the benefit of all members.54,pC-15

As its membership has grown, so has the Union's bureaucracy. The present structure of the Union consists of:

a. The Plenipotentiary Conference

b. Administrative Conferences

c. The Administrative Council

d. Permanent organs of the Union

1. the General Secretariat

2. the International Frequency Registration Board(IFRB)

3. the International Radio Consultative Committee(CCIR)

4. the International Telegraph and Telephone Consultative Committee (CCITT)

A. THE PLENIPOTENTIARY CONFERENCE

The Plenipotentiary Conference, which normally meets every five years, is composed of delegations representing members. Such conferences determine the general policies of the Union, review reports of the Administrative Council, establish the basis for the budget of the Union, elect the members of the Union which are to serve on the Administrative Council as well as the Secretary-General and Deputy Secretary-General, and revise the convention as considered necessary. Additionally, the Plenipoteniary Conference concludes or revises as necessary, agreements between the Union and other individual organizations.

B. THE ADMINISTRATIVE CONFERENCE

Administrative Conferences may be either world administrative or regional administrative conferences. Such conferences are convened to consider international telecommunications matters. The agenda of a world administrative conference may include the revision of the Administrative Regulations as well as other questions of world character within the competence of the conference. The International Radio Regulations stem from decisions of World Administrative Radio Conferences.

C. THE ADMINISTRATIVE COUNCIL

The Administrative Council, consisting of 36 members of the Union chosen with due regard for equitable representation of all parts of the world, meets annually and acts for the Plenipotentiary Conference between sessions of that body.

D. THE SECRETARY-GENERAL

The Secretary-General directs the General Secretariat and is responsible to the Administrative Council for the administrative and financial aspects of the Union's activity. It also coordinates the activities of the permanent organs of the Union, organizes the work of the General Secretariat, and undertakes the secretarial work prior to, during, and following conferences of the Union. It then prepares an annual report on the activities of the Union which, after approval by the Administrative Council, is transmitted to all members.

E. THE INTERNATIONAL FREQUENCY REGISTRATION BOARD

The International Frequency Registration Board (IFRB) effects the orderly recording of frequency assignments made by the different countries so as to establish, in accordance with the procedure provided for the Radio Regulations, the date, purpose and technical characteristics of each of these assignments. The IFRB performs this function with a view to ensuring formal international recognition to assignments, furnishing advice to members with a view to the operation of the maximum practical number of radio channels in those parts of the spectrum where harmful interference may occur; and performing such additional duties concerned with the assignment and use of the frequencies as may be prescribed by a competent conference of the Union or by the Administrative Council with the consent of the majority of the members. The maintenance of essential records is inherent to the performance of these duties.

F. THE INTERNATIONAL CONSULTATIVE COMMITTEES

The roles of the International Consultative Committees (CCI's) are essentially:

a. International Radio Consultative Committee (CCIR)-studies technical and operational questions relating specifically to radio communication and issues recommendations thereon;

b. International Telegraph and Telephone Consultative Committee (CCITT)-studies technical, operating, and tariff questions relating to telegraphy and telephony and issues recommendations thereon. [54,p.C-18]

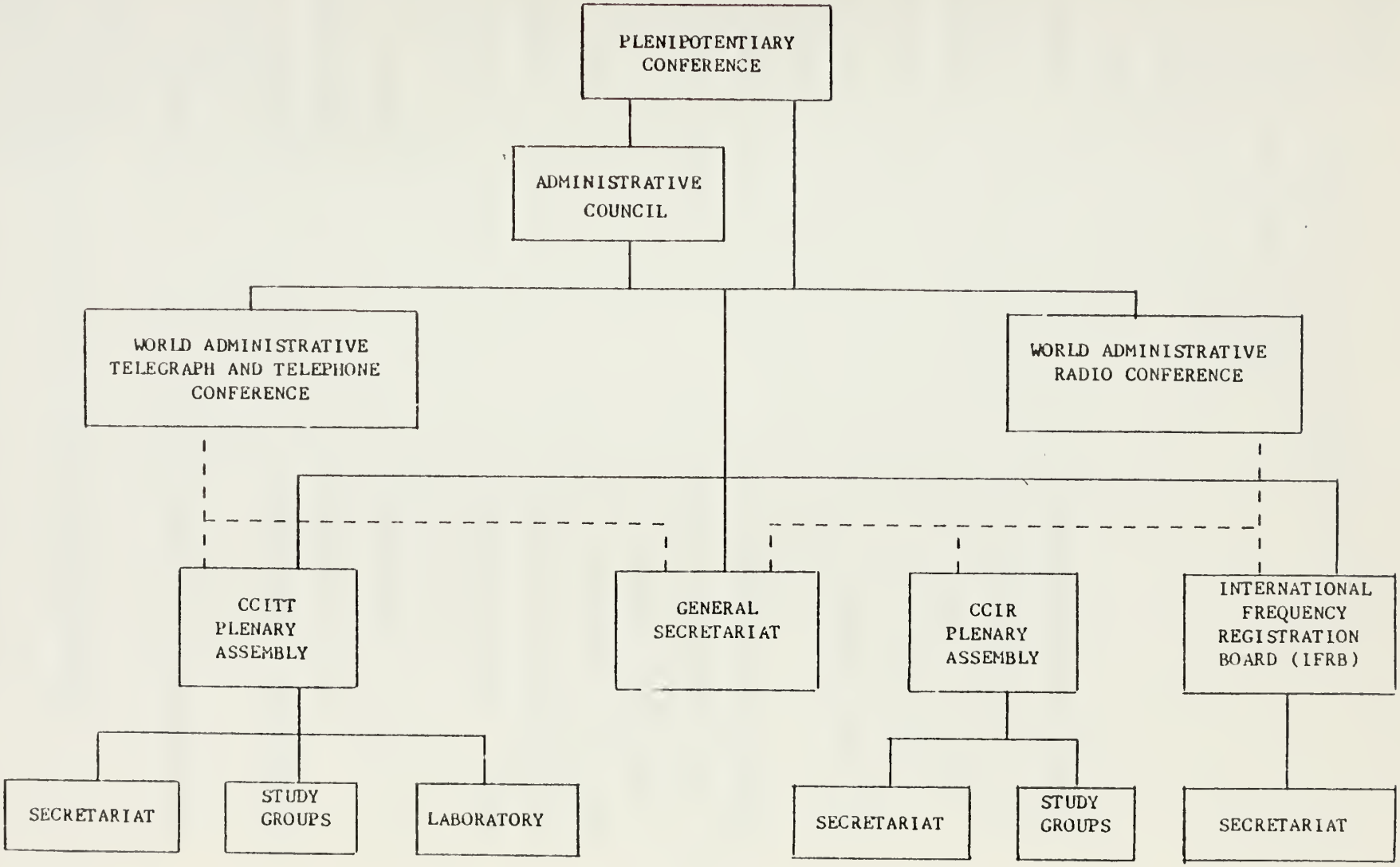
Recommendations of the CCI's Plenary Assemblies, when adopted by Administrative Conferences, become part of the International Regulations. The structure of the International Telecommunications Union is depicted in Figure 6.

An examination of the nature of the organization may give an indication of what any member can realistically hope to achieve in the ITU. Being an international organization, the ITU is made up of delegates with all the strengths, weaknesses, cultural and political differences of their individual and national backgrounds. The ITU like the U.N. provides a forum for the discussion and possible resolution of common problems. No agreement reached by the ITU is binding on members without their consent. In the United States the agreements carry treaty status and must receive the consent of two-thirds of the Senate for acceptance.

Once a proposal has been put forth member nations have the option of participating in the debate or withdrawing (usually a means of protest). If the proposal is accepted, the members

Figure 6

INTERNATIONAL TELECOMMUNICATION UNION ORGANIZATION



(Ref. 54, p.C-16)

choices are:

1) not to sign the final document.

2) sign with reservations.

3) ratify with reservations.

4) refuse to ratify.

5) ratify as presented.

The non-enforcing nature of the ITU decisions and policies was in previous years frustrating to the United States when we held influence over the majority.[7,p.8] Now that the United States often finds itself in the minority, the non-binding nature of the rules allows - the evasion of unpopular policies not perceived to be in U.S. national interests.

At the Montreux Conference of 1965 a resolution was proposed that would establish a special ITU Technical Assistance Fund over and above aid provided through the United Nations Development Fund. The motion was defeated at Montreux but was reintroduced and approved at Torremolinos in 1973 despite an announcement by the U.S. that it would refuse to contribute any amount. Other assistance resolutions passed at Torremolinos were:

1) Resolution 17, Improvement of Union Facilities for Rendering Technical Assistance to Developing Countries,

2) Resolution 18, Application of Science and Technology in the Interest of Developing Countries,

3) Resolution 19, Special Measures for the least-developed Countries, and

4) Opinion 2, Favorable Treatment for Developing Countries. [7,p.9]

These trends continued until the present one country one vote organization evolved. The contributory scheme is at present heavily weighted against the Developed Nations while the provided assistance is predominantly aimed at the developing nations.[6,p13]

For frequency allocation purposes the ITU has divided the World into three regions. These divisions allow for the duplication of frequency use to meet differing requirements in far reaching areas. Region one comprises the eastern Atlantic, all of Europe, Africa, Russia and the Middle East. Region two includes North America, South America and Greenland, Region three is made up of the remainder of the world, including Japan, China, Australia, most of Asia and the Indian sub continent.

Within each of these regions, frequencies are allocated to services. These services are:[46,p.1-2]

1. FIXED radio point-to-point communications such as microwave links and HF circuits between dedicated points. Communication Station circuits to the shore command and much of the Defense Communications System fall in this category.

2. Mobile radio communications between mobile units and between mobile and fixed stations. These circuits may be used by land, sea or air mobile units.

3. Aeronautical Mobile: Radio communications between an aircraft and ground station or between aircraft.

4. Maritime Mobile radio communications between ships and also ship to shore.

5. Land Mobile radio communications between a fixed base station and mobile land units or between mobile land units. Police, fire and taxi services are included in this category.

6. Radio Navigation position determining circuits that utilize the propagation characteristics of radio waves. This category includes navigation beacons, LORAN and OMEGA.

7. Aeronautical Radio Navigation radio navigation services intended for the use of aircraft. Examples are TACAN and airport aero radio beacons.

8. Maritime Radio Navigation radio services intended as navigation aids to ships such as coastal beacons and shipboard radars.

9. Radio location systems used for position determination other than navigation. Included in this category are shore radar installations, early warning radar systems and fire control radars for weapons systems.

10. Broadcasting radio communications intended for direct reception by the general public. Commercial radio and television come under this heading.

11. Amateur radio communications by and for persons interested in radio techniques solely as a personal interest. This includes non-commercial amateur radio circuits.

12. Space radio communications between space vehicles. The lunar module communications with the mother ship were part of this service as will be any direct satellite to satellite relays.

13. Earth-Space radio communications between earth stations and space stations. This category includes the Navy satellite to ship systems.

14. Radio Astronomy radio wave propagation used for the purpose of astronomy such as cosmic measurements based on radio wave propagation.

15. Standard Frequency radio wave transmission of high precision and accuracy used for technical and scientific purposes.

The ITU regulations concerning frequency allocations also specify required bandwidths, frequency tolerances, maximum power output and type of emission.

The required bandwidth is defined as the bandwidth necessary for the optimum efficient transmission of radio signals at rates and quality required for the specified system. Frequency tolerances are the maximum permissible departure by the center frequency of the frequency band occupied by an emission from the assigned frequency or, by the characteristic frequency of an emission from the reference frequency. The power output is defined as the mean power. That is the power supplied to the antenna transmission line by a transmitter during normal operation over a time period of sufficient length. A time of .1 seconds is normally used.

Emissions are defined as the type signal being transmitted. Those include the characteristics of the signal such as radiotelephony, single sidband, suppressed carrier, etc..

BIBLIOGRAPHY

1. A Summary Of The Federal Government's Use Of Radio Frequency Spectrum, NTIA, July 1978.

2. Archer, Gleason L., History Of Radio To 1926, American Historical Society, 1938.

3. Barnouw, Erik, A Tower Of Babel, A History Of Broadcasting In The U.S. Vol. I, Oxford Univ., 1966.

4. Berry, Leslie, "Measuring Spectrum Use" Wireless World, Vol., 84, Dec., 1978.

5. Board For International Broadcasting, ltr. of 19 Sept., 1978 to NTIA, Mr. Henry Geller.

6. Codding, George A. Jr., "The New Nations And The ITU: Some Policy Implications For The Future," Department Of Political Science, University Of Colorado At Boulder, April 1978.

7. Codding, George A. Jr., "The U.S. And The I.T.U. In A Changing World," Department Of Political Science, University Of Colorado.

8. Crispin, Howard L., "Earth Stations Dot The Globe," Microwave Systems News, 1 Oct. 1978.

9. Cuccia, C. Louis, "Bandwidth Conservation Is Essential," Microwave Systems News, 1 Oct. 1978.

10. Das, Satyen Dr., "Multibeam Antennas Improve Satellite Communication," Microwave System News, Mar. 1977.

11. Davis, George R., "Earth Stations Slim Down To Meet Grass Root Demands," Microwaves, Jan. 1977.

12. Department Of State, Office Of Telecommunications, TD. Serial No. 43, Report Of The United States Delegation To The Plenipotentiary Conference Of The International Telecommunications Union, Malaga - Torremolinos, Spain, September 14 - October 25, 1973, Washington, D.C., 1973.

13. Dummer, G. W. A., Electronics Inventions 1749 - 1976, Pergamon Press, 1977.

14. Durrani, Dr. S. H., Allen, C. C., and Noji, "Space Lab: Making Satcom Affordable," Microwave Systems News, Dec., 1977

15. Edden, Francie, "What's All This Noise In Satellite Communications Systems?," Microwave Systems News, Jun./July 1976.

16. Feldman, Mildred L. B., The U.S. In The International Telecommunications Union And Pre-ITU Conferences, LSU, 1975.

17. General Background Comments For Navy Frequency Representatives Attending GWARC 1979 Working Groups.

18. General World Administrative Radio Conference 1979: Preliminary, Department Of Navy Electromagnetic Spectrum Requirement, 1 April 1976.

19. Hinchman, Walter R., The Technological Environment For International Communications, A Paper In International Law Of Communications, McWhinney, 1971.

20. Howkins, John, "WARC '79", Telecommunications, Dec. 1977

21. I.T.U., International Telecommunications Convention Atlantic City, 1947. Atlantic City, N.J., 1947

22. ITU, International Telecommunications Convention Geneva, 1959, Geneva, Sw., 1960

23. Jacobsen, Harold, International Institutions For Telecommunications, The ITU's Role, A Paper in International Law Of Communications, Mc Whinney, 1971.

24. Johnsen, Katherine, "US To Oppose Broadcast Satellite Plan," Aviation Week And Space Technology, Jan. 10, 1977.

25. Kalba, Konradk, and Branscomb, Harvie, WARC'79, The Global Spectrum Rewrite.

26. Levin, Harvey J., The Invisible Resource, Use And Regulation Of The Radio Spectrum, Johns-Hopkins, 1971

27. Mayo, R. W., Wittman, W. W., The Structure, Conduct And Performance Of The U.S. Telecommunication Industry, A Thesis, N.P.S. 1977

28. Mili, M., "Editorial," Telecommunications Journal, Vol. 41, No. VIII, August 1974

29. Moncrief, Frank J., "Europeans Preparing For Direct TV Broadcasting Via Satellite," Microwave Systems News, October 1, 1978.

30. Moynihan, Daniel P., "The United States In Opposition," Commentary, March, 1975

31. National Telecommunications And Information Administration, Manual Of Regulations And Procedures For Radio Frequency Management, revision 1 September 1978.

32. Ohlsen, John, Satellite Communications Reference Data Book, DCA, 1972.

33. Oliver, John W., History Of American Technology, Ronald Press, 1956.

34. Pelton, Joeseph N., Global Communications Satellite Policy: Intelsat, Politics And Functionalism, Lomond, 1974

35. Plummer, W. E., The Interdepartment Radio Advisory Committee, Fifty Years Of Service In Radio Communications, A Paper Prepared For OTP, 13 Jan. 1972.

36. Preliminary Department Of Navy Electromagnetic Spectrum Requirement, Department Of Navy, 1976

37. President's Task Force On Communications Policy, Final Report, 7 Dec. 1968.

38. Pritchard, Wilbur L., "Satellite Communication - An Overview Of The Problems And Programs," IEEE, 1977

39. Probst, Samuel E., "International And U.S. Preparations For The 1979 World Administrative Radio Conference," Senior Member IEEE, IEEE Transactions On Electromagnetic Compatibility Vol. EMC-19, No. 3, Aug., 1977.

40. Probst, Samuel E., "Ltr. of 30 Aug., 1978", to Executive Secretary Irac.

41. Probst, Samuel E., "Ltr. of 17 Nov., 1977," to Ad Hoc 144 Committee.

42. Provisional List Of Issues For WARC: Political Profile Survey, 16 Feb. 1978

43. Radio Spectrum Utilization, The Joint Technical Advisory Committee Of The IEEE, IEEE, 1965.

44. Reaccommendation Of Displaced Assignments If HF Fixed Service Allocations Are Reduced Considerably By WARC 1979, IRAC Ad Hoc 144-Ie, 13 July 1978.

45. Read, William H., Coming: A Law Of Communications Conference, Working Paper W-77-2, Harvard University Program On Information Resources Policy, April 1977

46. Reference Data For Radio Engineers, ITT, Howard Sams, Co., 1975

47. Richardson, Elliot L., "U.S. Department Of Commerce Projects and Services, Signal, January 1977

48. "Satellite Technology Evolves," Microwave Systems News, Dec., 1977.

49. Schmitt, Harrison, Speech Before Armed Forces Communication-Electroniec Assn., 20 June 1978.

50. Southworth, George C., Forty Years Of Radio Research, Gordon and Breach, 1962

51. Spectrum Engineering - The Dey To Progress, A Report On Technical Policies And Procedures For Increased Radio Spectrum Utilization, A Report Of The Joint Technical Advisory Committee Of The Institute Of Electrical And Electronics Engineering And Electronic Industries Association, March 1968.

52. Spectrum Planning Digest, Department Of Defense Electromagnetic Compatibility Analysis Center, Vol. I, No. 24, 2 Oct. 1978

53. Spectrum Planning Digest, Department of Defense Electromagnetic Compatibility Analysis Center, Vol. III. No. 13, 24 Oct. 1978.

54. The Radio Frequency Spectrum, U.S. Use And Management, Office Of Telecommunications Policy, 1975.

55. The WARC Review (3-78), Navy Electromagnetic Spectrum Center, Naval Communication Unit, Vol. II, No. 3, Cheltenham, Md., Aug. 1978.

56. Time Sharing Between High-Frequency Broadcasting And Fixed Services, CCIR Study Groups, Special Preparatory Meeting (WARC - 79) Geneva, 1978, 19 Sept. 1978.

57. U.S. Congress, Committee on Interstate And Foreign Commerce, Subcommittee on Communications, Hearings, May 25, 1977, 95th Congress 1st Session.

58. U.S. Department of Commerce, National Telecommunications And Information Administration, Doc. 2040011-4.3.113.1. 24/1.9.144 GRC - 1669 - I, Government Position With Respect To U.S. WARC - 79 Proposals For Expansion Of H.F. Broadcast Bands, 30 Aug. 1978.

59. U.S. Department of State, Telecommunications Division, Report of the Chairman of the United States Delegation to the Plenipotentiary Conference of the International Telecommunication Union, Geneva, Switzerland, October - December 1959, (TD Serial No. 900); 15 Jan. 1960.

60. U.S. Department of State, Office of Telecommunications, Report of the United States Delegation to the Plenipotentiary Conference of the International Telecommunication Union, Montreaux, Soitzerland, September 14 to November 12, 1965, (TD Serial No. 973) Washington, D. C., 15 Dec. 1965.

61. Walsh, John, "Encounters With The Third World Seen In Allocating Frequencies," Science, Vol. 201, 11 Aug. 1978.

62. Weatherford, Jack E., "U.S. Preparation for the World Administrative Radio Conference 1979," Signal, April 1976.

63. "What's Happening with the High Band-Frequency Changes," Sea Technology, May 1977.

64. Wheaton, Martha, Preparation For WARC '79, A Thesis, NPS, 1975.

65. Williams, Johns, "World Administrative Radio Conference 1979," Signal, Jan. 1978.

66. Woldman, Joel M., An Introduction to the Foreign Policy Implications of the 1979 WARC, A Paper Prepared for OTP, 31, Mar 1978.

67. World Administrative Radio Conference To Deal With Matters Relating to the Maritime Mobile Service, Final Acts, Geneva, 1967

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